

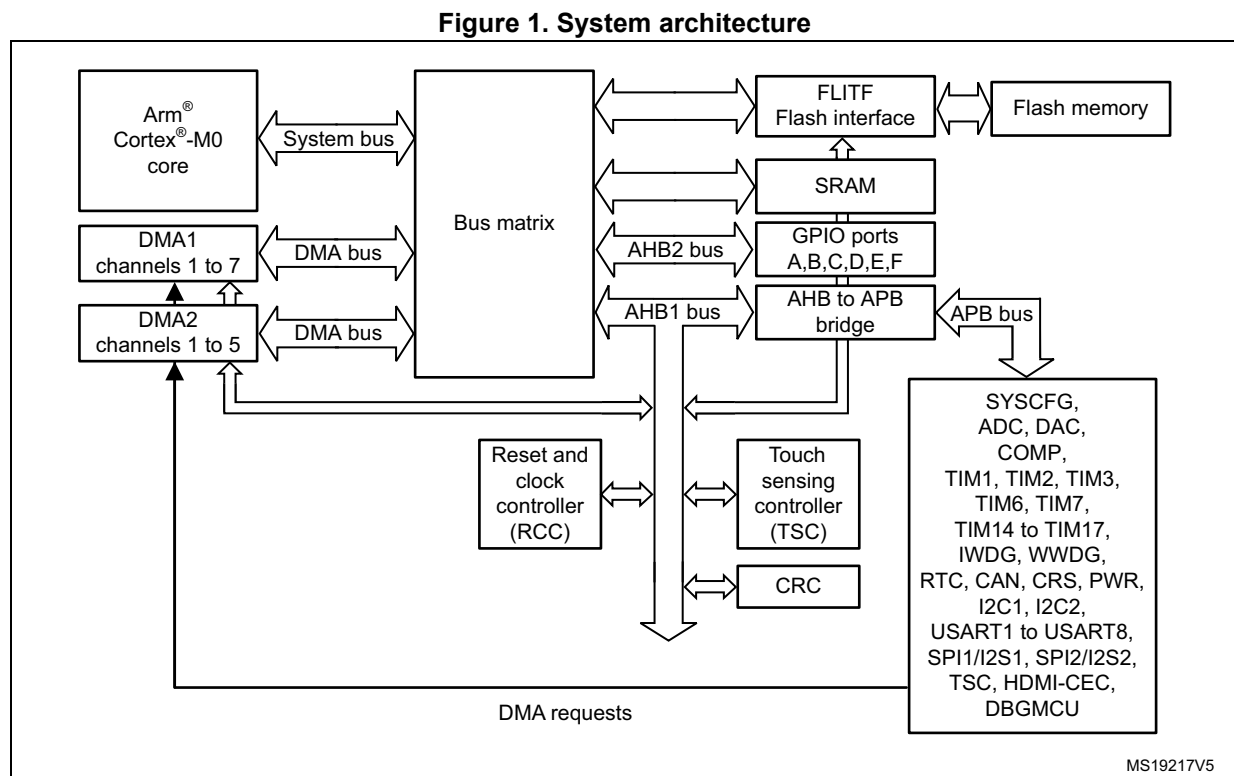
2 System and memory overview

2.1 System architecture

The main system consists of:

- Up to three masters:
 - Cortex®-M0 core
 - General-purpose DMA1
 - General purpose DMA2 (available on STM32F09x devices only)
- Four slaves:
 - Internal SRAM
 - Internal flash memory
 - AHB1 with AHB to APB bridge, which connects all the APB peripherals
 - AHB2 dedicated to GPIO ports

These are interconnected using a multilayer AHB bus architecture, as shown in [Figure 1](#):



System bus

This bus connects the system bus of the Cortex®-M0 core (peripherals bus) to a BusMatrix which manages the arbitration between the core and the DMA.

DMA bus

This bus connects the AHB master interface of the DMA to the BusMatrix which manages the access of CPU and DMA to SRAM, flash memory and peripherals.

BusMatrix

The BusMatrix manages the access arbitration between the core system bus and the DMA master bus. The arbitration uses a Round Robin algorithm. The BusMatrix is composed of up to three masters (CPU, DMA1, DMA2) and four slaves (FLITF, SRAM, AHB1 with AHB to APB bridge and AHB2).

AHB peripherals are connected on system bus through a BusMatrix to allow DMA access.

AHB to APB bridge (APB)

The AHB to APB bridge provides full synchronous connections between the AHB and the APB bus.

Refer to [Section 2.2.2: Memory map and register boundary addresses](#) for the address mapping of the peripherals connected to this bridge.

After each device reset, all peripheral clocks are disabled (except for the SRAM and flash). Before using a peripheral you have to enable its clock in the RCC_AHBENR, RCC_APB2ENR or RCC_APB1ENR register.

Note: When a 16- or 8-bit access is performed on an APB register, the access is transformed into a 32-bit access: the bridge duplicates the 16- or 8-bit data to feed the 32-bit vector.

2.2 Memory organization

2.2.1 Introduction

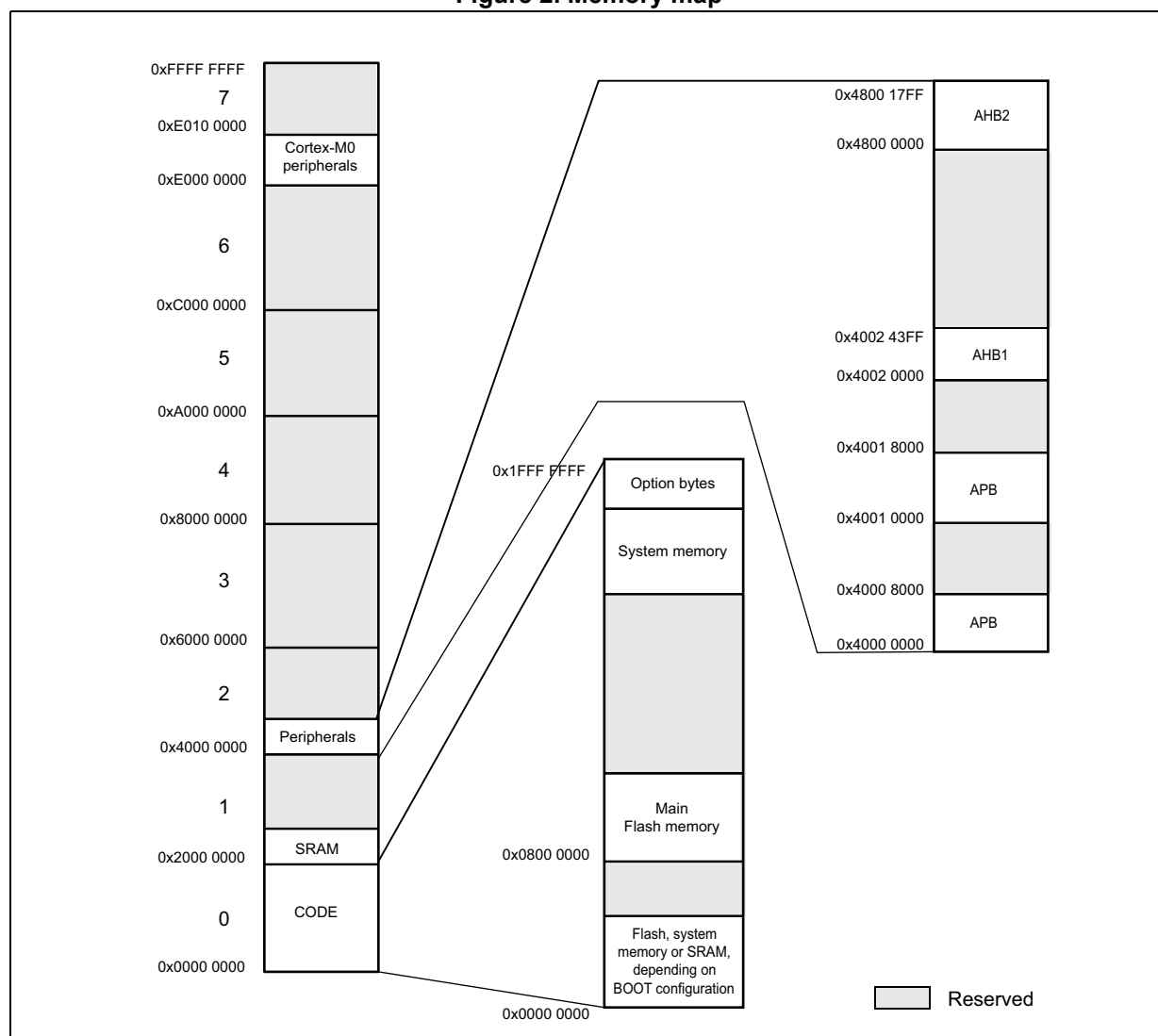
Program memory, data memory, registers and I/O ports are organized within the same linear 4-Gbyte address space.

The bytes are coded in memory in Little Endian format. The lowest numbered byte in a word is considered the word's least significant byte and the highest numbered byte the most significant.

The addressable memory space is divided into eight main blocks, of 512 Mbytes each.

2.2.2 Memory map and register boundary addresses

Figure 2. Memory map



All the memory map areas not allocated to on-chip memories and peripherals are considered “Reserved”. For the detailed mapping of available memory and register areas, refer to the following table, which gives the boundary addresses of the available peripherals.

Table 1. STM32F0xx peripheral register boundary addresses

Bus	Boundary address	Size	Peripheral	Peripheral register map
-	0xE000 0000 - 0xE00F FFFF	1MB	Cortex®-M0 internal peripherals	-
-	0x4800 1800 - 0x5FFF FFFF	~384 MB	Reserved	-

Table 1. STM32F0xx peripheral register boundary addresses (continued)

Bus	Boundary address	Size	Peripheral	Peripheral register map
AHB2	0x4800 1400 - 0x4800 17FF	1KB	GPIOF	Section 8.4.12 on page 164
	0x4800 1000 - 0x4800 13FF	1KB	GPIOE	Section 8.4.12 on page 164
	0x4800 0C00 - 0x4800 0FFF	1KB	GPIOD	Section 8.4.12 on page 164
	0x4800 0800 - 0x4800 0BFF	1KB	GPIOC	Section 8.4.12 on page 164
	0x4800 0400 - 0x4800 07FF	1KB	GPIOB	Section 8.4.12 on page 164
	0x4800 0000 - 0x4800 03FF	1KB	GPIOA	Section 8.4.12 on page 164
-	0x4002 4400 - 0x47FF FFFF	~128 MB	Reserved	-
AHB1	0x4002 4000 - 0x4002 43FF	1 KB	TSC	Section 16.6.11 on page 326
	0x4002 3400 - 0x4002 3FFF	3 KB	Reserved	-
	0x4002 3000 - 0x4002 33FF	1 KB	CRC	Section 12.5.6 on page 232
	0x4002 2400 - 0x4002 2FFF	3 KB	Reserved	-
	0x4002 2000 - 0x4002 23FF	1 KB	FLASH interface	Section 3.5.9 on page 75
	0x4002 1400 - 0x4002 1FFF	3 KB	Reserved	-
	0x4002 1000 - 0x4002 13FF	1 KB	RCC	Section 6.4.15 on page 136
	0x4002 0800 - 0x4002 0FFF	2 KB	Reserved	-
	0x4002 0400 - 0x4002 07FF	1 KB	DMA2	Section 10.6.8 on page 212
	0x4002 0000 - 0x4002 03FF	1 KB	DMA	Section 10.6.8 on page 212
-	0x4001 8000 - 0x4001 FFFF	32 KB	Reserved	-

Table 1. STM32F0xx peripheral register boundary addresses (continued)

Bus	Boundary address	Size	Peripheral	Peripheral register map
APB	0x4001 5C00 - 0x4001 7FFF	9 KB	Reserved	-
	0x4001 5800 - 0x4001 5BFF	1 KB	DBGMCU	Section 32.9.6 on page 934
	0x4001 4C00 - 0x4001 57FF	3 KB	Reserved	-
	0x4001 4800 - 0x4001 4BFF	1 KB	TIM17	Section 20.6.17 on page 558
	0x4001 4400 - 0x4001 47FF	1 KB	TIM16	Section 20.6.17 on page 558
	0x4001 4000 - 0x4001 43FF	1 KB	TIM15	Section 20.5.19 on page 541
	0x4001 3C00 - 0x4001 3FFF	1 KB	Reserved	-
	0x4001 3800 - 0x4001 3BFF	1 KB	USART1	Section 27.8.12 on page 765
	0x4001 3400 - 0x4001 37FF	1 KB	Reserved	-
	0x4001 3000 - 0x4001 33FF	1 KB	SPI1/I2S1	Section 28.9.10 on page 824
	0x4001 2C00 - 0x4001 2FFF	1 KB	TIM1	Section 17.4.21 on page 402
	0x4001 2800 - 0x4001 2BFF	1 KB	Reserved	-
	0x4001 2400 - 0x4001 27FF	1 KB	ADC	Section 13.12 on page 274
	0x4001 2000 - 0x4001 23FF	1 KB	Reserved	-
	0x4001 1C00 - 0x4001 1FFF	1 KB	USART8	Section 27.8.12 on page 765
	0x4001 1800 - 0x4001 1BFF	1 KB	USART7	Section 27.8.12 on page 765
	0x4001 1400 - 0x4001 17FF	1 KB	USART6	Section 27.8.12 on page 765
	0x4001 0800 - 0x4001 13FF	3 KB	Reserved	-
	0x4001 0400 - 0x4001 07FF	1 KB	EXTI	Section 11.3.7 on page 225
	0x4001 0000 - 0x4001 03FF	1 KB	SYSCFG COMP	Section 9.1.38 on page 185 Section 15.5.2 on page 308
-	0x4000 8000 - 0x4000 FFFF	32 KB	Reserved	-

Table 1. STM32F0xx peripheral register boundary addresses (continued)

Bus	Boundary address	Size	Peripheral	Peripheral register map
APB	0x4000 7C00 - 0x4000 7FFF	1 KB	Reserved	-
	0x4000 7800 - 0x4000 7BFF	1 KB	CEC	Section 31.7.7 on page 919
	0x4000 7400 - 0x4000 77FF	1 KB	DAC	Section 14.10.15 on page 299
	0x4000 7000 - 0x4000 73FF	1 KB	PWR	Section 5.4.3 on page 94
	0x4000 6C00 - 0x4000 6FFF	1 KB	CRS	Section 7.7.5 on page 147
	0x4000 6800 - 0x4000 6BFF	1 KB	Reserved	-
	0x4000 6400 - 0x4000 67FF	1 KB	CAN	Section 29.9.5 on page 864
	0x4000 6000 - 0x4000 63FF	1 KB	USB/CAN SRAM	Section 30.6.3 on page 900
	0x4000 5C00 - 0x4000 5FFF	1 KB	USB	Section 30.6.3 on page 900
	0x4000 5800 - 0x4000 5BFF	1 KB	I2C2	Section 26.7.12 on page 698
	0x4000 5400 - 0x4000 57FF	1 KB	I2C1	Section 26.7.12 on page 698
	0x4000 5000 - 0x4000 53FF	1 KB	USART5	Section 27.8.12 on page 765
	0x4000 4C00 - 0x4000 4FFF	1 KB	USART4	Section 27.8.12 on page 765
	0x4000 4800 - 0x4000 4BFF	1 KB	USART3	Section 27.8.12 on page 765
	0x4000 4400 - 0x4000 47FF	1 KB	USART2	Section 27.8.12 on page 765
	0x4000 3C00 - 0x4000 43FF	2 KB	Reserved	-
	0x4000 3800 - 0x4000 3BFF	1 KB	SPI2	Section 28.9.10 on page 824
	0x4000 3400 - 0x4000 37FF	1 KB	Reserved	-
	0x4000 3000 - 0x4000 33FF	1 KB	IWDG	Section 23.4.6 on page 582
	0x4000 2C00 - 0x4000 2FFF	1 KB	WWDG	Section 24.5.4 on page 588
	0x4000 2800 - 0x4000 2BFF	1 KB	RTC	Section 25.7.18 on page 628
	0x4000 2400 - 0x4000 27FF	1 KB	Reserved	-
	0x4000 2000 - 0x4000 23FF	1 KB	TIM14	Section 19.4.13 on page 490
	0x4000 1800 - 0x4000 1FFF	2 KB	Reserved	-
	0x4000 1400 - 0x4000 17FF	1 KB	TIM7	Section 21.4.9 on page 572
	0x4000 1000 - 0x4000 13FF	1 KB	TIM6	Section 21.4.9 on page 572
	0x4000 0800 - 0x4000 0FFF	2 KB	Reserved	-
	0x4000 0400 - 0x4000 07FF	1 KB	TIM3	Section 18.4.19 on page 469
	0x4000 0000 - 0x4000 03FF	1 KB	TIM2	Section 18.4.19 on page 469

Table 2. STM32F0xx memory boundary addresses

Device	Boundary address	Size	Memory Area	Register description
STM32F03x	0x2000 1000 - 0x3FFF FFFF	~512 MB	Reserved	-
	0x2000 0000 - 0x2000 0FFF	4 KB	SRAM	Section 2.3 on page 52
	0x1FFF FC00 - 0x1FFF FFFF	1 KB	Reserved	-
	0x1FFF F800 - 0x1FFF FBFF	1 KB	Option bytes	Section 4 on page 76
	0x1FFF EC00 - 0x1FFF F7FF	3 KB	System memory	-
	0x0800 8000 - 0x1FFF EBFF	~384 MB	Reserved	-
	0x0800 0000 - 0x0800 7FFF	32 KB	Main flash memory	Section 3 on page 56
	0x0000 8000 - 0x07FF FFFF	~128 MB	Reserved	-
	0x0000 0000 - 0x0000 7FFF	32 KB	Main flash memory, system memory or SRAM depending on BOOT configuration	-
STM32F04x	0x2000 1800 - 0x3FFF FFFF	~512 MB	Reserved	-
	0x2000 0000 - 0x2000 17FF	6 KB	SRAM	Section 2.3 on page 52
	0x1FFF FC00 - 0x1FFF FFFF	1 KB	Reserved	-
	0x1FFF F800 - 0x1FFF FBFF	1 KB	Option bytes	Section 4 on page 76
	0x1FFF C400 - 0x1FFF F7FF	13 KB	System memory	-
	0x0801 8000 - 0x1FFF C7FF	~384 MB	Reserved	-
	0x0800 0000 - 0x0801 7FFF	32 KB	Main flash memory	Section 3 on page 56
	0x0001 8000 - 0x07FF FFFF	~128 MB	Reserved	-
	0x0000 0000 - 0x0000 7FFF	32 KB	Main flash memory, system memory or SRAM depending on BOOT configuration	-
STM32F05x	0x2000 2000 - 0x3FFF FFFF	~512 MB	Reserved	-
	0x2000 0000 - 0x2000 1FFF	8 KB	SRAM	Section 2.3 on page 52
	0x1FFF FC00 - 0x1FFF FFFF	1 KB	Reserved	-
	0x1FFF F800 - 0x1FFF FBFF	1 KB	Option bytes	Section 4 on page 76
	0x1FFF EC00 - 0x1FFF F7FF	3 KB	System memory	-
	0x0801 0000 - 0x1FFF EBFF	~384 MB	Reserved	-
	0x0800 0000 - 0x0800 FFFF	64 KB	Main flash memory	Section 3 on page 56
	0x0001 0000 - 0x07FF FFFF	~128 MB	Reserved	-
	0x0000 0000 - 0x0000 FFFF	64 KB	Main flash memory, system memory or SRAM depending on BOOT configuration	-

Table 2. STM32F0xx memory boundary addresses (continued)

Device	Boundary address	Size	Memory Area	Register description
STM32F07x	0x2000 4000 - 0x3FFF FFFF	~512 MB	Reserved	-
	0x2000 0000 - 0x2000 3FFF	16 KB	SRAM	Section 2.3 on page 52
	0x1FFF F800 - 0x1FFF FFFF	2 KB	Option bytes	Section 4 on page 76
	0x1FFF C800 - 0x1FFF F7FF	12 KB	System memory	-
	0x0802 0000 - 0x1FFF C7FF	~384 MB	Reserved	-
	0x0800 0000 - 0x0801 FFFF	128 KB	Main flash memory	Section 3 on page 56
	0x0002 0000 - 0x07FF FFFF	~128 MB	Reserved	-
	0x0000 0000 - 0x0001 FFFF	128 KB	Main flash memory, system memory or SRAM depending on BOOT configuration	-
STM32F09x	0x2000 8000 - 0x3FFF FFFF	~512 MB	Reserved	-
	0x2000 0000 - 0x2000 7FFF	32 KB	SRAM	Section 2.3 on page 52
	0x1FFF F800 - 0x1FFF FFFF	2 KB	Option bytes	Section 4 on page 76
	0x1FFF D800 - 0x1FFF F7FF	8 KB	System memory	-
	0x0804 0000 - 0x1FFF D7FF	~384 MB	Reserved	-
	0x0800 0000 - 0x0803 FFFF	256 KB	Main flash memory	Section 3 on page 56
	0x0004 0000 - 0x07FF FFFF	~128 MB	Reserved	-
	0x0000 0000 - 0x0003 FFFF	256 KB	Main flash memory, system memory or SRAM depending on BOOT configuration	-

2.3 Embedded SRAM

STM32F03x devices feature 4 Kbytes of static SRAM. STM32F04x devices feature 6 Kbytes of static SRAM. STM32F05x devices feature 8 Kbytes of static SRAM. STM32F07xS devices feature 16 Kbytes of static SRAM. STM32F09x devices feature 32 Kbytes of static SRAM.

This RAM can be accessed as bytes, half-words (16 bits) or full words (32 bits). This memory can be addressed at maximum system clock frequency without wait state and thus by both CPU and DMA.

Parity check

The user can enable the parity check using the option bit RAM_PARITY_CHECK in the user option byte (refer to [Section 4: Option bytes](#)).

The data bus width is 36 bits because 4 bits are available for parity check (1 bit per byte) in order to increase memory robustness, as required for instance by Class B or SIL norms.

The parity bits are computed and stored when writing into the SRAM. Then, they are automatically checked when reading. If one bit fails, an NMI is generated. The same error can also be linked to the BRK_IN Break input of TIM1/15/16/17, with the

SRAM_PARITY_LOCK control bit in the [SYSCFG configuration register 2 \(SYSCFG_CFGR2\)](#). The SRAM Parity Error flag (SRAM_PEF) is available in the [SYSCFG configuration register 2 \(SYSCFG_CFGR2\)](#).

Note: When enabling the RAM parity check, it is advised to initialize by software the whole RAM memory at the beginning of the code, to avoid getting parity errors when reading non-initialized locations.

2.4 Flash memory overview

The flash memory is composed of two distinct physical areas:

- The main flash memory block. It contains the application program and user data if necessary.
- The information block. It is composed of two parts:
 - option bytes for hardware and memory protection user configuration
 - system memory which contains the proprietary boot loader code (refer to [Section 3: Embedded flash memory](#) for more details.)

The flash interface implements instruction access and data access based on the AHB protocol. It implements the prefetch buffer that speeds up CPU code execution. It also implements the logic necessary to carry out the flash memory operations (Program/Erase) controlled through the flash registers.

2.5 Boot configuration

In the STM32F0xx, three different boot modes can be selected through the BOOT0 pin and boot configuration bits nBOOT1, BOOT_SEL and nBOOT0 in the User option byte, as shown in the following table.

Table 3. Boot modes ⁽¹⁾

Boot mode configuration				Mode
nBOOT1 bit	BOOT0 pin	BOOT_SEL bit	nBOOT0 bit	
x	0	1	x	Main flash memory is selected as boot area ⁽²⁾
1	1	1	x	System memory is selected as boot area
0	1	1	x	Embedded SRAM is selected as boot area
x	x	0	1	Main flash memory is selected as boot area
1	x	0	0	System memory is selected as boot area
0	x	0	0	Embedded SRAM is selected as boot area

1. Grey options are available on STM32F04x and STM32F09x devices only.

2. For STM32F04x and STM32F09x devices, see also Empty check description.

The boot mode configuration is latched on the 4th rising edge of SYSCLK after a reset. It is up to the user to set boot mode configuration related to the required boot mode.

The boot mode configuration is also re-sampled when exiting from Standby mode. Consequently they must be kept in the required Boot mode configuration in Standby mode. After this startup delay has elapsed, the CPU fetches the top-of-stack value from address 0x0000 0000, then starts code execution from the boot memory at 0x0000 0004.

Depending on the selected boot mode, main flash memory, system memory or SRAM is accessible as follows:

- Boot from main flash memory: the main flash memory is aliased in the boot memory space (0x0000 0000), but still accessible from its original memory space (0x0800 0000). In other words, the flash memory contents can be accessed starting from address 0x0000 0000 or 0x0800 0000.
- Boot from system memory: the system memory is aliased in the boot memory space (0x0000 0000), but still accessible from its original memory space (0x1FFF EC00 on STM32F03x and STM32F05x devices, 0x1FFF C400 on STM32F04x devices, 0x1FFF C800 on STM32F07x and 0x1FFF D800 on STM32F09x devices).
- Boot from the embedded SRAM: the SRAM is aliased in the boot memory space (0x0000 0000), but it is still accessible from its original memory space (0x2000 0000).

Empty check

On STM32F04x and STM32F09x devices only, internal empty check flag is implemented to allow easy programming of virgin devices by the boot loader. This flag is used when BOOT0 pin is defining Main flash memory as the target boot area. When the flag is set, the device is considered as empty and System memory (boot loader) is selected instead of the main flash as a boot area to allow user to program the flash memory.

This flag is updated only during the loading of option bytes: it is set when the content of the address 0x08000000 is read as 0xFFFF FFFF, otherwise it is cleared. It means a power reset or setting of OBL_LAUNCH bit in FLASH_CR register is needed to clear this flag after programming of a virgin device to execute user code after System reset.

Note: If the device is programmed for a first time but the option bytes are not reloaded, the device still selects System memory as a boot area after a System reset. In the STM32F04x, the boot loader code is able to detect this situation. It then changes the boot memory mapping to main flash and performs a jump to user code programmed there. In the STM32F09x, a POR must be performed or the Option bytes reloaded before applying the system reset.

Physical remap

Once the boot mode is selected, the application software can modify the memory accessible in the code area. This modification is performed by programming the MEM_MODE bits in the [SYSCFG configuration register 1 \(SYSCFG_CFGR1\)](#). Unlike Cortex® M3 and M4, the M0 CPU does not support the vector table relocation. For application code which is located in a different address than 0x08000000, some additional code must be added in order to be able to serve the application interrupts. A solution is to relocate by software the vector table to the internal SRAM:

- Copy the vector table from the flash (mapped at the base of the application load address) to the base address of the SRAM at 0x20000000.
- Remap SRAM at address 0x00000000, using SYSCFG configuration register 1.
- Then once an interrupt occurs, the Cortex®-M0 processor fetches the interrupt handler start address from the relocated vector table in SRAM, then it jumps to execute the interrupt handler located in the flash.

This operation should be done at the initialization phase of the application. Please refer to AN4065 and attached IAP code from www.st.com for more details.

Embedded boot loader

The embedded boot loader is located in the System memory, programmed by ST during production. It is used to reprogram the flash memory using one of the following serial interfaces:

- USART on pins PA9/PA10, PA14/PA15 or PA2/PA3
- I2C on pins PB6/PB7 (STM32F04xxx, STM32F07xxx and STM32F09xxx devices only)
- USB DFU interface (STM32F04xxx and STM32F07xxx devices only)

For further details, refer to the application note AN2606.