第06次實習課

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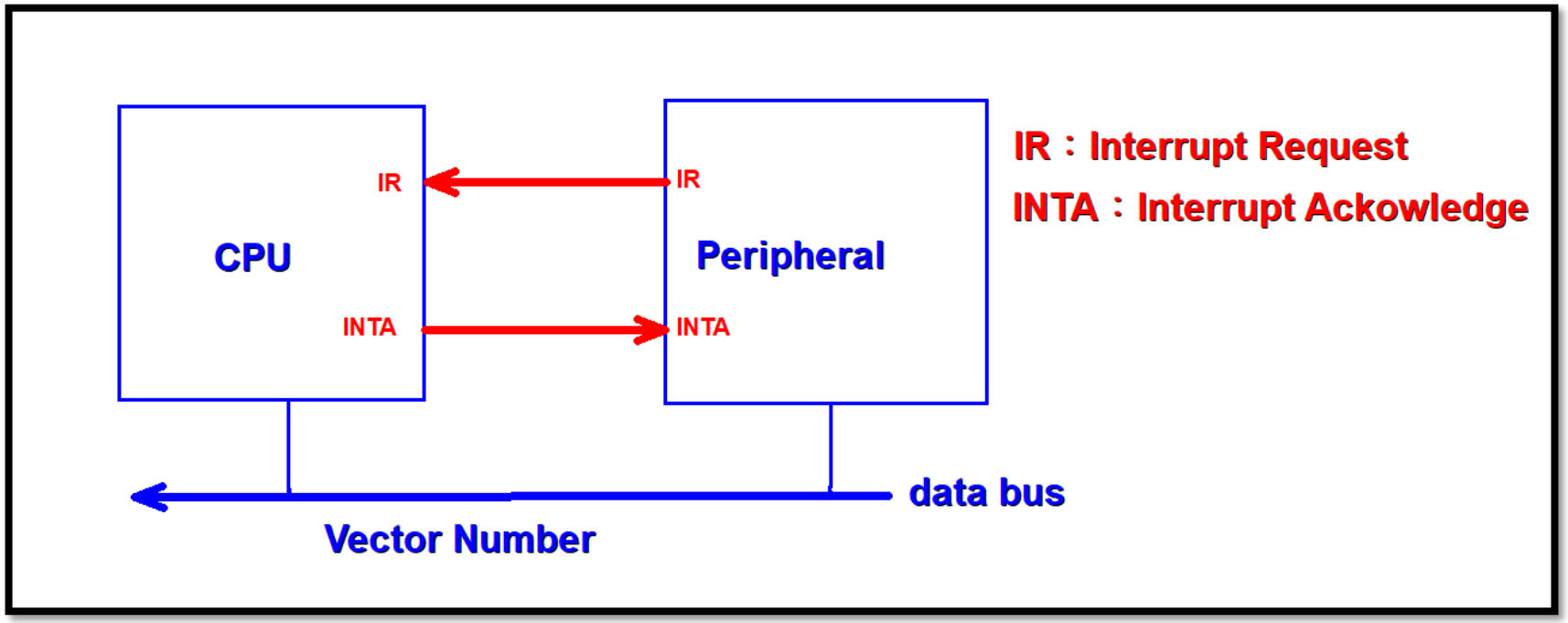
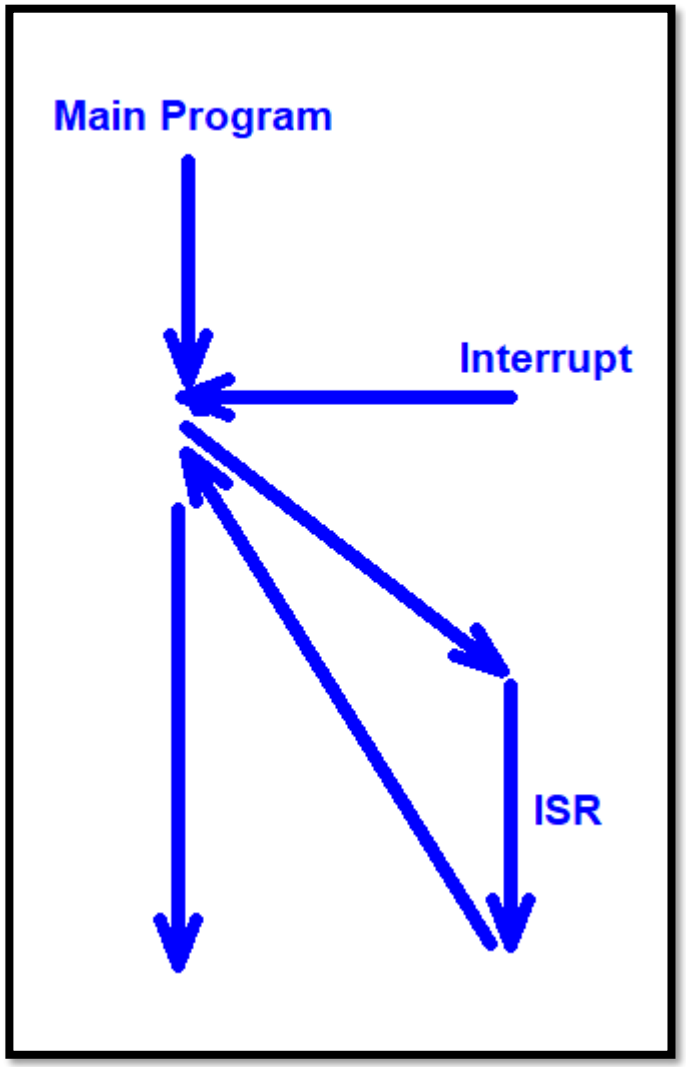
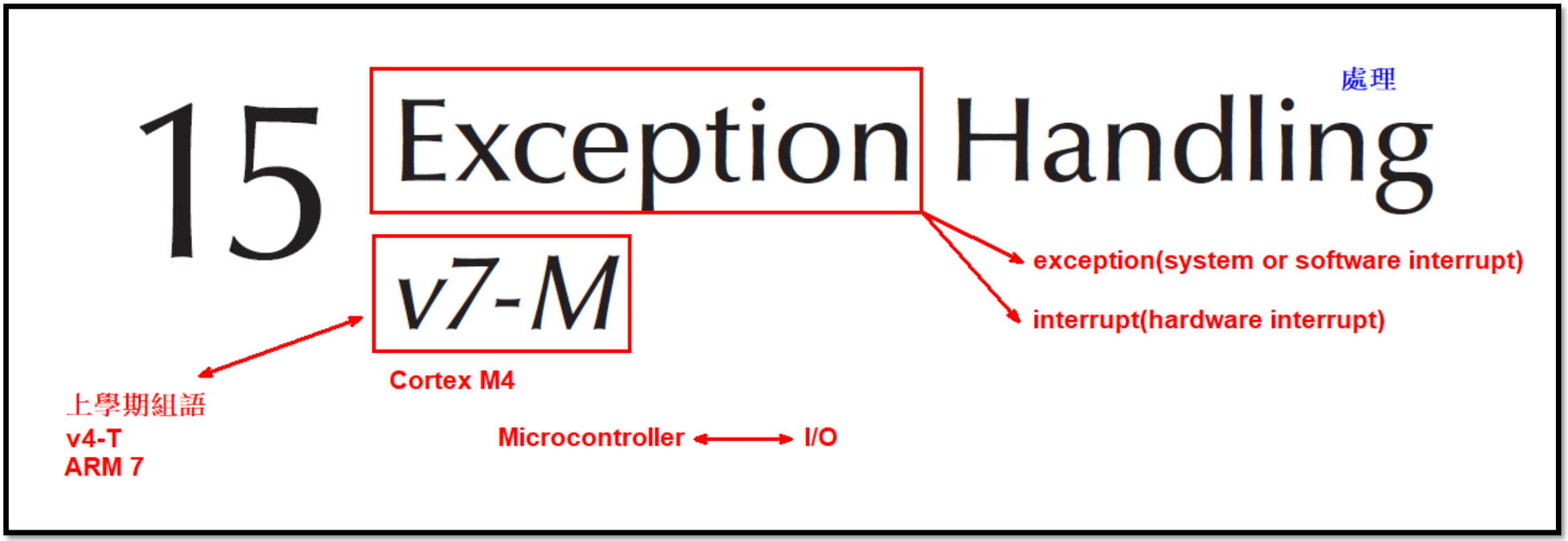
P347 複習





中斷請求（IRQ）是指外部設備或系統組件向處理器發送的信號，通知處理器發生了一個事件，需要處理器的處理或注意。這些事件可以是來自硬件設備（例如鍵盤、滑鼠、網絡卡等）的請求，也可以是系統內部的事件（例如錯誤或異常情況）。

中斷確認（Interrupt Acknowledge）則是處理器對中斷請求的回應。當處理器收到中斷請求後，會向相應的中斷控制器發送中斷確認信號，以確認它已經收到了中斷請求並準備好處理中斷。這個信號的發送通知外部設備或中斷控制器，處理器已準備好處理中斷，可以開始進行中斷服務程序。


15 Exception Handling
處理
v7-M
Cortex M4
exception(system or software interrupt)
interrupt(hardware interrupt)
上學期組語
v4-T
ARM 7
Microcontroller
I/O

P326 FIGURE 15.1

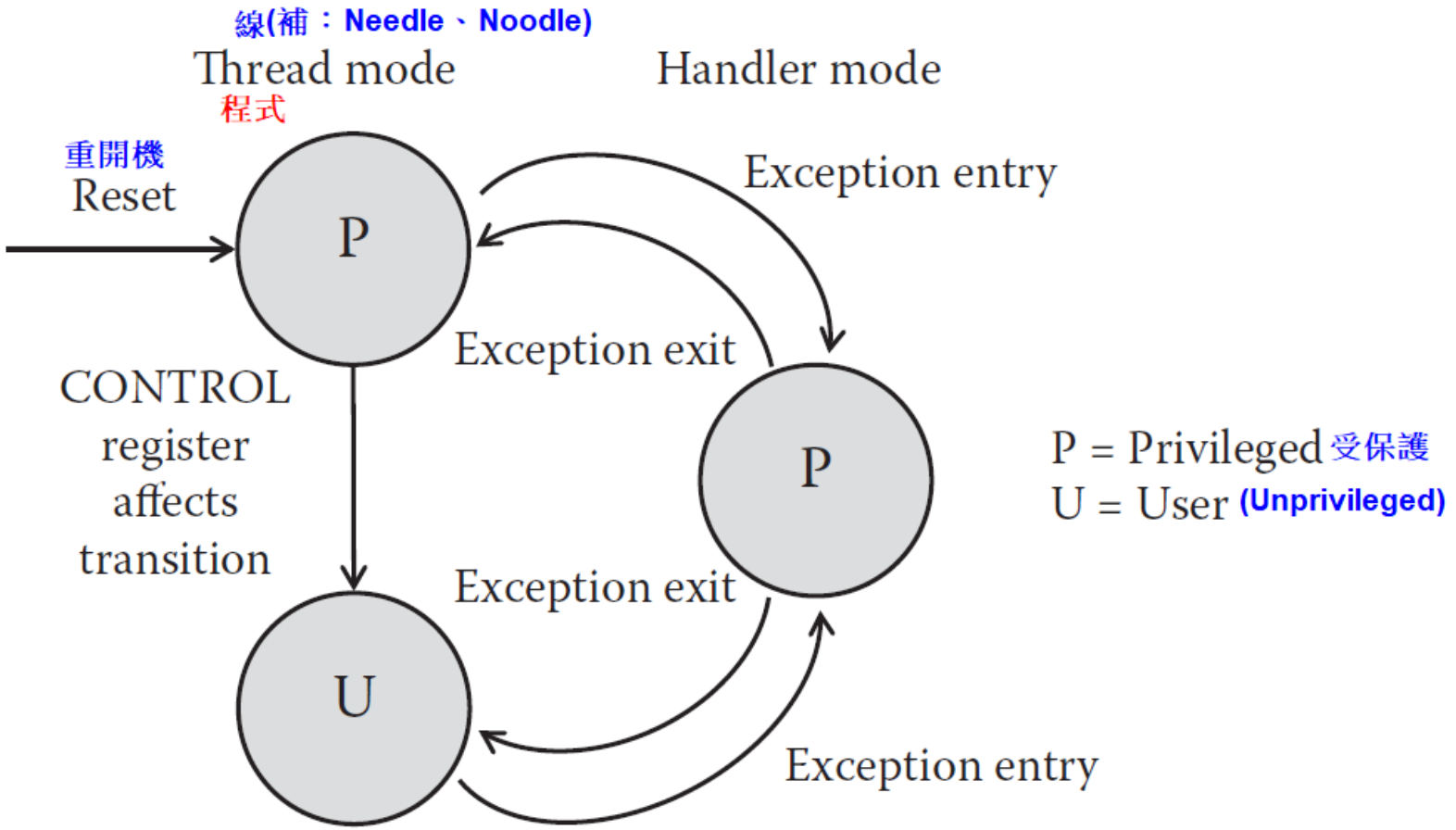
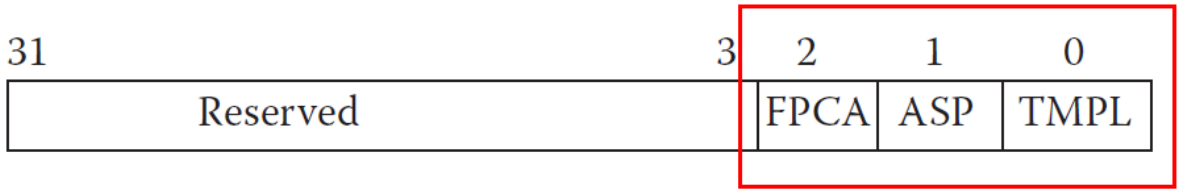


FIGURE 15.1 Cortex-M4 operation modes.

P326 FIGURE 15.2



FPCA – Floating-point context active

1 – Preserve floating-point state when processing exception

0 – No floating-point context active

ASP - Active stack pointer

1 – PSP

0 – MSP

TMPL - Thread mode privilege level

1 – Unprivileged

0 – Privileged

FIGURE 15.2 CONTROL Register on the Cortex-M4.

P327 EXAMPLE 15.1

EXAMPLE 15.1

切中要害/點的

We'll return to this example later in the chapter, with some modifications along the way, as it demonstrates the various aspects of exception handling in the Cortex-M4. Let's begin by building a quick-and-dirty routine that forces the processor into privileged Handler mode from privileged Thread mode. In Chapter 7, the idea of trapping division by zero was only mentioned, leaving an actual case study until now. If you type the following example into the Keil tools, using a Tiva TM4C1233H6PM as the target processor, and then single-step through the code, just out of reset the processor will begin executing the instructions after the label Reset_Handler. Note that many of the registers are memory mapped. For the full list of registers, see the Tiva TM4C1233H6PM Microcontroller Data Sheet (Texas Instruments 2013b).

抓到

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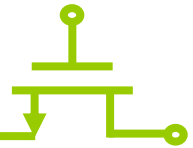

Unsigned DIV

Signed DIV (SDIV)

```
; this divide works just fine
UDIV        r4, r2, r1 ; r4 = r2 / r1
; this divide takes an exception
UDIV        r5, r3, r0
```

系統造成的錯誤

硬體中斷
(request/acknowledge handshake)

X

```
DCD     StackMem + Stack    ; Top of Stack
DCD     Reset_Handler       ; Reset Handler
DCD     NmiISR              ; NMI Handler
DCD     FaultISR            ; Hard Fault Handler
DCD     IntDefaultHandler   ; MPU Fault Handler
DCD     IntDefaultHandler   ; Bus Fault Handler
DCD     IntDefaultHandler   ; Usage Fault Handler
```

5

X+4*5 X+4*vector number

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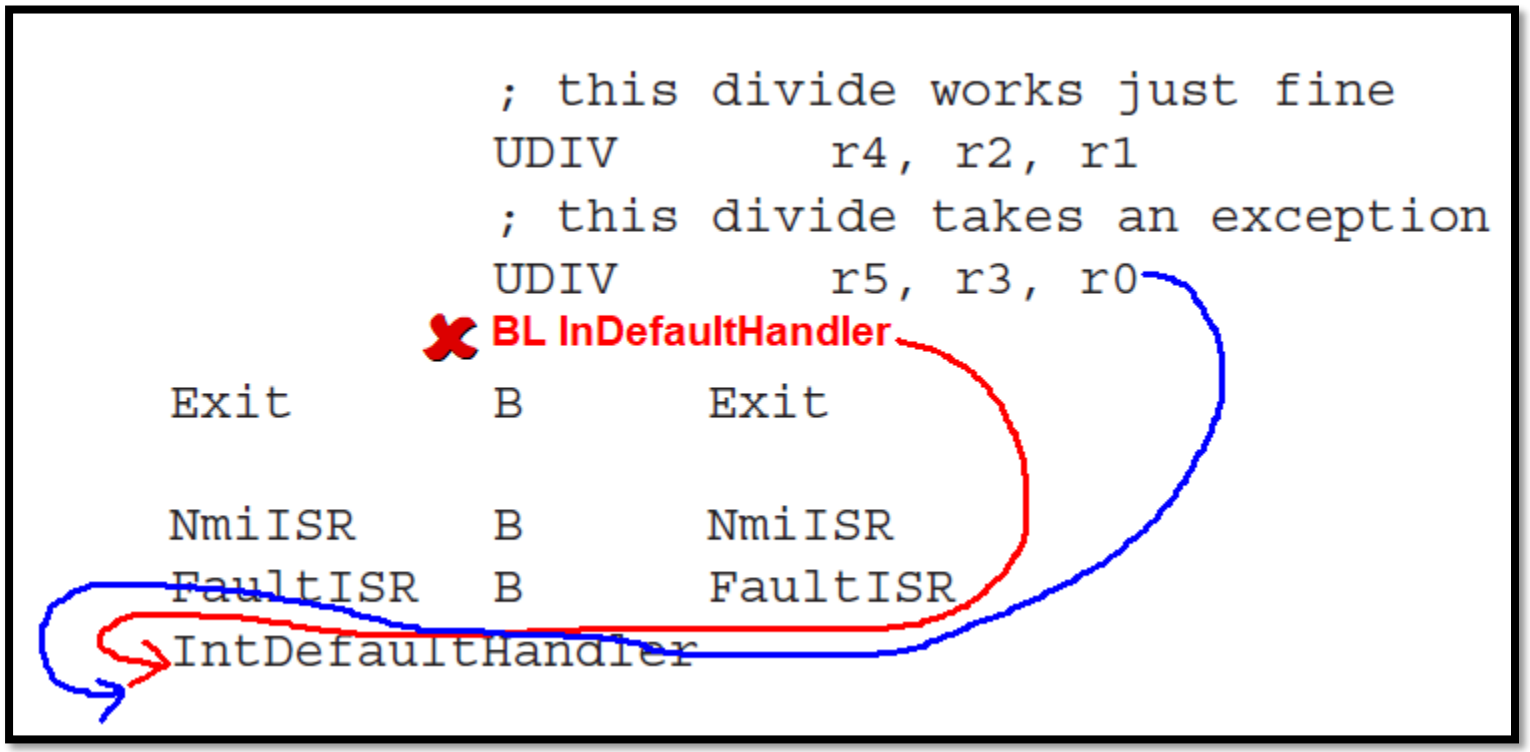


1. 系統開機(Reset Handler)
2. 製造Exception(除以0)
3. 查找vector table
4. 執行例外處理程式

P327 EXAMPLE 15.1

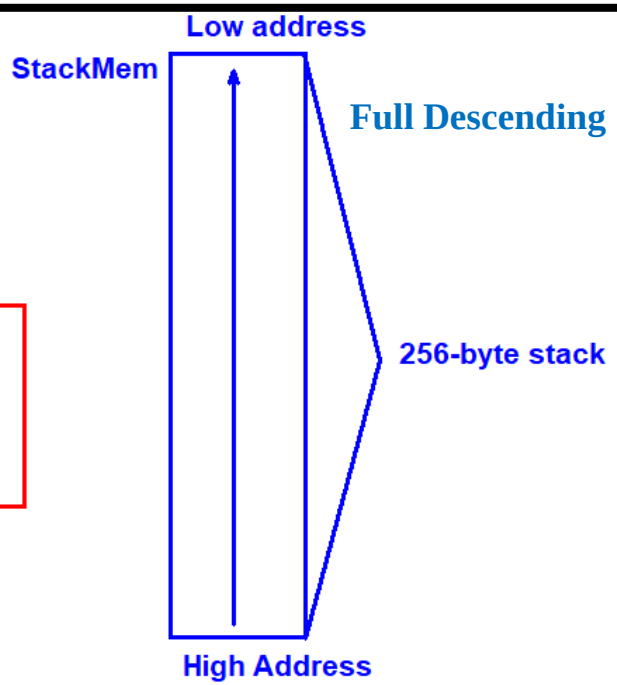
```
Stack           EQU     0x00000100
DivbyZ          EQU     0xD14
SYSHNDCTRL      EQU     0xD24
Usagefault      EQU     0xD2A
NVICBase        EQU     0xE000E000

        AREA    STACK, NOINIT, READWRITE, ALIGN=3
StackMem
        SPACE   Stack
        PRESERVE8

        AREA RESET, CODE, READONLY
        THUMB

; The vector table sits here
; We'll define just a few of them and leave the rest at 0 for now 例：

        DCD     StackMem+Stack          ; Top of Stack暫存、恢復所使用的堆疊
        DCD     Reset_Handler           ; Reset Handler
        DCD     NmiISR                  ; NMI Handler
        DCD     FaultISR                ; Hard Fault Handler
        DCD     IntDefaultHandler       ; MPU Fault Handler
        DCD     IntDefaultHandler       ; Bus Fault Handler
        DCD     IntDefaultHandler       ; Usage Fault Handler
```



transmit
STMIA
LDMDB
(Empty Ascending)
(參考P281)

TABLE 13.1
Stack-Oriented Suffixes

Stack Type	PUSH	POP
Full descending	STMFD (STMDB)	LDMFD (LDMIA)
Full ascending	STMFA (STMIB)	LDMFA (LDMDA)
Empty descending	STMED (STMDA)	LDMED (LDMIB)
Empty ascending	STMEA (STMIA)	LDMEA (LDMDB)

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TABLE 15.1
Exception Types and Vector Table

Table Offset

Exception Type	Exception Number	Priority	Vector Address	Caused by…
—	—	—	0x00000000	Top of stack
Reset	1	– 3 (highest)	0x00000004	Reset
NMI	2	– 2	0x00000008	Non-maskable interrupt
Hard fault	3	– 1	0x0000000C	All fault conditions if the corresponding fault is not enabled
Mem mgmt fault	4	Programmable	0x00000010	MPU violation or attempted access to illegal locations
Bus fault	5	Programmable	0x00000014	Bus error, which occurs during AHB transactions when fetching instructions or data
Usage fault	6	Programmable	0x00000018	Undefined instructions, invalid state on instruction execution, and errors on exception return
—	7–10	—		Reserved
SVcall	11	Programmable	0x0000002C	Supervisor Call
Debug monitor	12	Programmable	0x00000030	Debug monitor requests such as watchpoints or breakpoints
—	13	—		Reserved
PendSV	14	Programmable	0x00000038	Pendable Service Call
SysTick	15	Programmable	0x0000003C	System Tick Timer
Interrupts	16 and above	Programmable	0x00000040 and above	Interrupts

P327 EXAMPLE 15.1

```
Stack       EQU     0x00000100
DivbyZ      EQU     0xD14
SYSHNDCTRL  EQU     0xD24
Usagefault  EQU     0xD2A
NVICBase    EQU     0xE000E000   Nested Vector Interrupt Controller
```

秘書長 (其他周邊晶片是秘書)

Q&A

Thanks for your attention !!