使用 HT82K95E 實現與 PC 的資料傳輸

文件編碼：HA0267T

簡介

HT82K95E 是盛群推出的的 USB Keyboard OTP MCU，符合 USB HID 1.1 規格相容產品，具備 4Kx15 ROM Size、160 Bytes RAM、3 個端點(FIFO Size 爲 8Bytes)可規劃爲 Boot Device Keyboard、Mouse 產品，具有 USB、PS/2 硬體自動判斷輔助介面，適用於 USB USB + PS/2 產品開發。

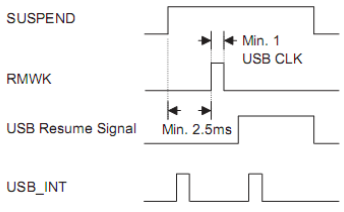
本範例將介紹 HT82K95E 與 PC 的資料傳輸，將端點 1 配置爲 IN，端點 2 配置爲 OUT，透過 PC 端的測試軟體利用中斷傳輸實現 8 Bytes 資料的輸入與輸出。

Theory of Operation

跟 USB 相關的暫存器有 13 個，包括 USC(1AH)、USR(1BH)、SCC(1CH)、Pipe_ctrl(41H)、AWR(42H)、STALL(43H)、PIPE(44H)、SIES(45H)、MISC(46H)、Endpt_EN(47H)、FIFO0(48H)、FIFO1(49H)、FIFO2(4AH)。

USC 暫存器的定義

如果在 USB 總線上超過 3ms 沒有信號，設備將進入 Suspend Mode，此時 USC 暫存器中的 SUSP 位元將被設定 1，並產生 USB 中斷，如下圖所示。爲了減小 Suspend 電流需要清除 SCC 暫存器中的 USBCKEN 位元，爲了進一步降低功耗可以通過設定位元 SUSPEND2 來實現。當設備接收到主機發送的 Resume 信號時，MCU 會產生中斷，此時我們需要打開 USB 的時鐘，即 USBCKEN=1，並清除 SUSP2。



HT82K95E 支援 Remote Wake-up 功能，如果設備配置爲具有該功能時，設備通過控制 RMWK 發送一個 Wake-up 脈衝來喚醒 USB 主機，如上圖所示。

Bit No.	Label	R/W	Function
0	SUSP	R	Read only, USB suspend indication. When this bit is set to "1" (set by SIE), it indicates the USB bus enters suspend mode. The USB interrupt is also triggered on any changes of this bit.
1	RMWK	W	USB remote wake up command. It is set by MCU to force the USB host leaving the suspend mode. When this bit is set to "1", 2μs delay for clearing this bit to "0" is needed to insure the RMWK command is accepted by SIE.
2	URST	R/W	USB reset indication. This bit is set/cleared by USB SIE. This bit is used to detect which bus (PS2 or USB) is attached. When the URST is set to "1", this indicates that a USB reset has occurred (the attached bus is USB) and a USB interrupt will be initialized.
3	RESUME	R	USB resume indication. When the USB leaves the suspend mode, this bit is set to "1" (set by SIE). This bit will appear 20ms waiting for the MCU to detect. When the RESUME is set by the SIE, an interrupt will be generated to wake-up the MCU. In order to detect the suspend state, the MCU should set the USBCKEN and clear SUSP2 (in SCC register) to enable the SIE detecting function. The RESUME will be cleared while the SUSP is going "0". When the MCU is detecting the SUSP, the RESUME (wakes-up the MCU) should be remembered and taken into consideration.
4	PS2DAI	R	Read only, USBD-/DATA input
5	PS2CKI	R	Read only, USBD+/CLK input
6	PS2DAO	W	Data for driving the USBD-/DATA pin when working under 3D PS2 mouse function. (Default="1")
7	PS2CKO	W	Data for driving the USBD+/CLK pin when working under 3D PS2 mouse function. (Default="1")

USC (1AH) Register

USR 暫存器的定義

USR 暫存器中 EP0IF、EP1IF、EP2IF 用來指示是 USB 中斷是由存取端點 0、端點 1 還是端點 2 引起的，SPS2 和 SUSB 是用來選擇 MCU 工作在 PS2 模式還是 USB 模式，USB-flag 指示 MCU 工作在 USB 模式。

Bit No.	Label	R/W	Function
0	EP0IF	R/W	When this bit is set to "1" (set by the SIE), it indicates the endpoint 0 is accessed and a USB interrupt will occur. When the interrupt has been served, this bit should be cleared by firmware.
1	EP1IF	R/W	When this bit is set to "1" (set by the SIE), it indicates the endpoint 1 is accessed and a USB interrupt will occur. When the interrupt has been served, this bit should be cleared by firmware.
2	EP2IF	R/W	When this bit is set to "1" (set by the SIE), it indicates the endpoint 2 is accessed and a USB interrupt will occur. When the interrupt has been served, this bit should be cleared by firmware.
3, 6	—	—	Reserved
4	SPS2	R/W	The PS2 function is selected when this bit is set to "1". (Default="0")
5	SUSB	R/W	The USB function is selected when this bit is set to "1". (Default="0")
7	USB_flag	R/W	This flag is used to show the MCU is in USB mode. (Bit=1) This bit is R/W by FW and will be cleared to "0" after power-on reset. (Default="0")

USR (1BH) Register

SCC 暫存器的定義

SCC 暫存器中 USBCKEN 用於控制 USB Clock，SYSCLK 用於選擇系統時鐘採用 6MHz 還是 12MHz，PS2_flag 用來指示 MCU 工作在 PS2 模式。

Bit No.	Label	R/W	Function
2~0, 7	—	—	Undefined, should be cleared to "0"
3	USBCKEN	R/W	USB clock control bit. When this bit is set to "1", it indicates that the USB clock is enabled. Otherwise, the USB clock is turned-off. (Default="0")
4	SUSP2	R/W	This bit is used to reduce power consumption in the suspend mode. In the normal mode this bit must be cleared to zero (Default=0). In the HALT mode this bit should be set high to reduce power consumption. If in USB mode set this bit LVR OPT must disable
5	PS2_flag	R/W	This flag is used to show the MCUis under PS2 mode. (Bit=1) This bit is R/W by FW and will be cleared to "0" after power-on reset. (Default="0")
6	SYSCLK	R/W	This bit is used to specify the system oscillator frequency used by the MCU. If a 6MHz crystal oscillator or resonator is used, this bit should be set to "1". If a 12MHz crystal oscillator or resonator is used, this bit should be cleared to "0" (default).

SCC (1CH) Register

AWR 暫存器的定義

AWR 暫存器用於控制遠程喚醒功能和設定 USB 設備的位址。

Bit No.	Label	R/W	Function
0	WKEN	W	Remote wake-up enable/disable
7~1	AD6~AD0	W	USB device address

AWR (42H) Register

Pipe_ctrl 暫存器的定義

Pipe_ctrl 暫存器用於控制 USB 端點的方向(IN 或 OUT)。

STALL 暫存器的定義

STALL 暫存器用於控制 USB 端點進去 STALL 狀態。

PIPE 暫存器的定義

PIPE 暫存器用於指示主機是否存取相應的端點。

Endpt_EN 暫存器的定義

Endpt_EN 用於 Enable 或 Disable 相應的端點，爲 1 Enable 端點，爲 0 則 Disable。

Register Name	R/W	Register Address	Bit7~Bit3 Reserved	Bit 2	Bit 1	Bit 0	Default Value
PIPE_CTRL	R/W	01000001B	—	Pipe 2	Pipe 1	Pipe 0	00000110
STALL	R/W	01000011B	—	Pipe 2	Pipe 1	Pipe 0	00000110
PIPE	R	01000100B	—	Pipe 2	Pipe 1	Pipe 0	00000000
Endpt_EN	R/W	01000001B	—	Pipe 2	Pipe 1	Pipe 0	00000111

PIPE_CTRL (41H), STALL (43H), PIPE (44H) and Endpt_EN (47H) Registers

SIES 暫存器的定義

Bit No.	Function	Read/Write	Register Address
7	MNI	R/W	01000001B
6~2	—	—	
1	F0_ERR	R/W	
0	Adr_set	R/W	

SIES (45H) Register Table

MISC 暫存器的定義

Bit No.	Label	R/W	Function
0	REQ	R/W	After setting the other status of the desired one in the MISC, endpoint FIFO can be requested by setting this bit to "1". After the job has been done, this bit has to be cleared to "0".
1	TX	R/W	This bit defines the direction of data transferring between MCU and endpoint FIFO. When the TX is set to "1", this means that the MCU wants to write data to the end-point FIFO. After the job has been done, this bit has to be cleared to "0" before termi-nating request to represent the end of transferring. For reading action, this bit has to be cleared to "0" to represent that MCU wants to read data from the endpoint FIFO and has to be set to "1" after the job is done.
2	CLEAR	R/W	Clear the requested endpoint FIFO, even if the endpoint FIFO is not ready.
4 3	SELP1 SELP0	R/W	Defines which endpoint FIFO is selected, SELP1,SELP0: 00: endpoint FIFO0 01: endpoint FIFO1 10: endpoint FIFO2 11: reserved
5	SCMD	R/W	Used to show that the data in endpoint FIFO is a SETUP command. This bit has to be cleared by firmware. That is to say, even the MCU is busy, the device will not miss any SETUP commands from the host.
6	READY	R	Read only status bit, this bit is used to indicate that the desired endpoint FIFO is ready to work.
7	LEN0	R/W	Used to indicate that a 0-sized packet is sent from a host to the MCU. This bit should be cleared by firmware.

MISC (46H) Register

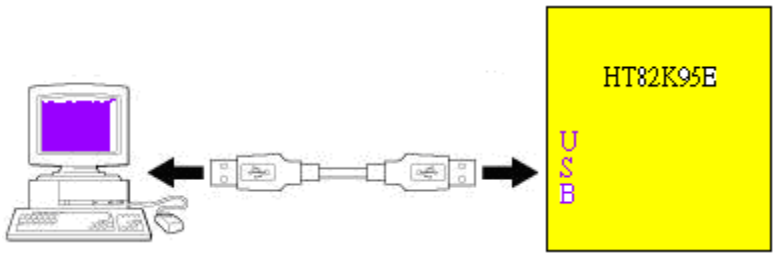
在 MISC 暫存器中有幾個跟 USB FIFO 讀取相關的設定，可分爲寫入 FIFO 與讀取 FIFO 的時序。以下圖來說明 FIFO 寫入和讀取的時序。

Read FIFO Timing　　Write FIFO Timing

Actions	MISC Setting Flow and Status
Read FIFO0 sequence	00H→01H→delay 2μs, check 41H→read* from FIFO0 register and check not ready (01H)→03H→02H
Write FIFO1 sequence	0AH→0BH→delay 2μs, check 4BH→write* to FIFO1 register and check not ready (0BH)→09H→08H
Check whether FIFO0 can be read or not	00H→01H→delay 2μs, check 41H (ready) or 01H (not ready)→00H
Check whether FIFO1 can be written or not	0AH→0BH→delay 2μs, check 4BH (ready) or 0BH (not ready)→0AH
Read 0-sized packet sequence form FIFO0	00H→01H→delay 2μs, check 81H→read once (01H)→03H→02H
Write 0-sized packet sequence to FIFO1	0AH→0BH→delay 2μs, check 0BH→0FH→0DH→08H

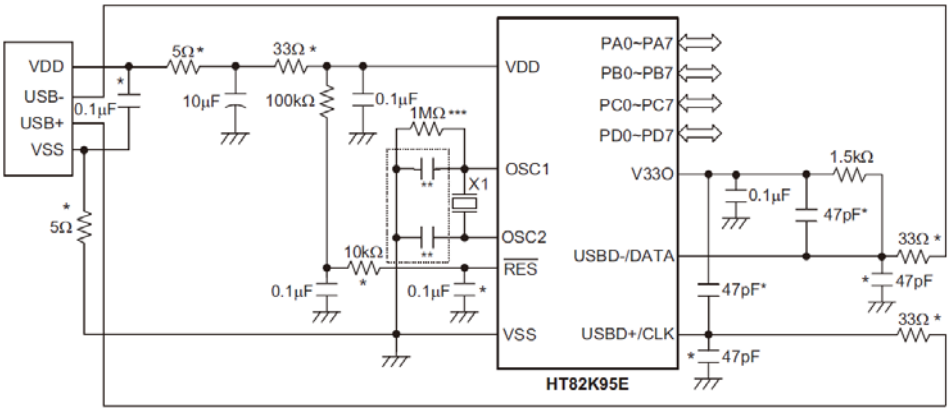
Note: *: There are 2μs existing between 2 reading action or between 2 writing action

H/W Function Block Diagram



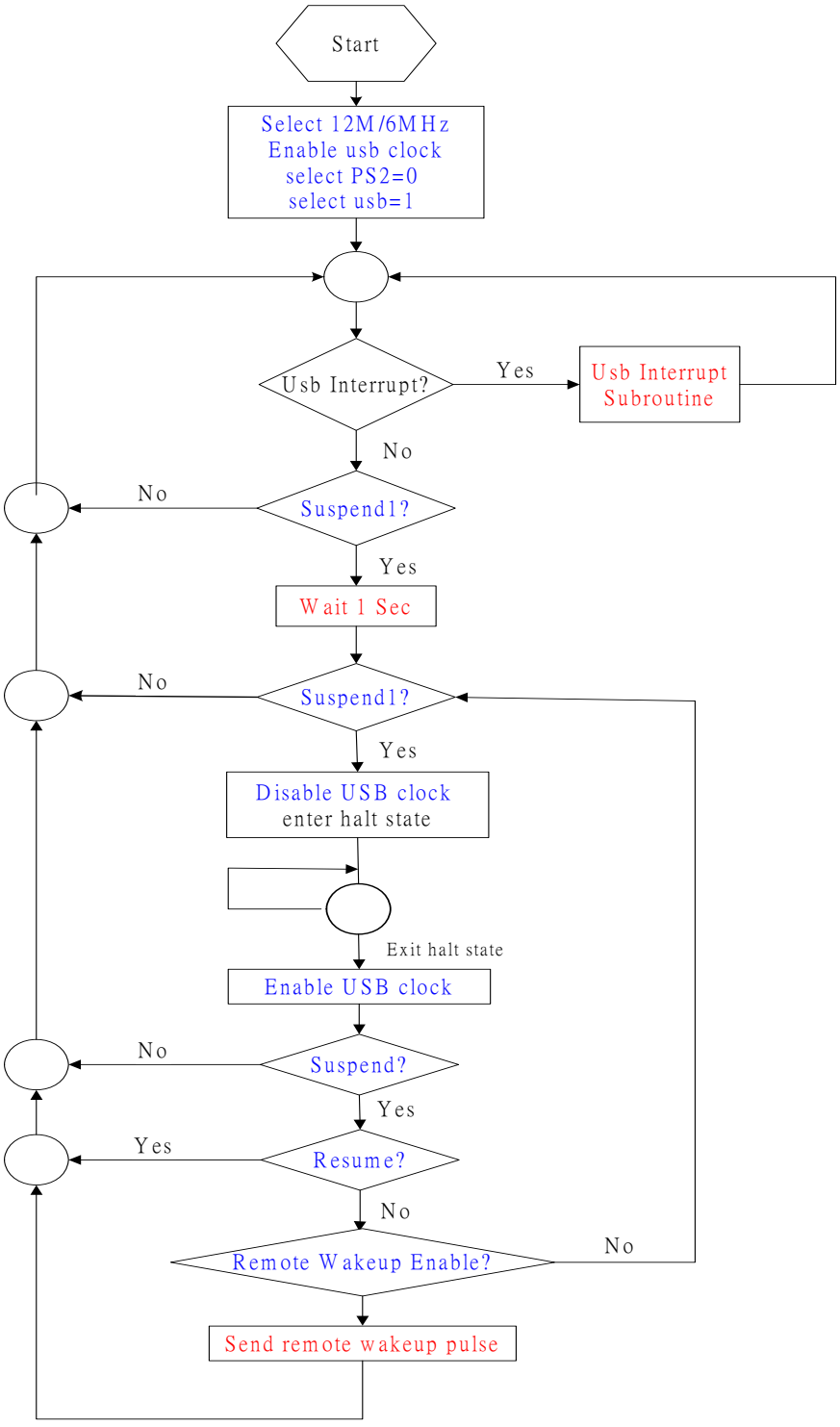
PC 透過 USB 向 HT82K95E 傳輸 8 Bytes 的資料，HT82K95E 收到資料後，將這筆資料回傳給 PC。

Application Circuit



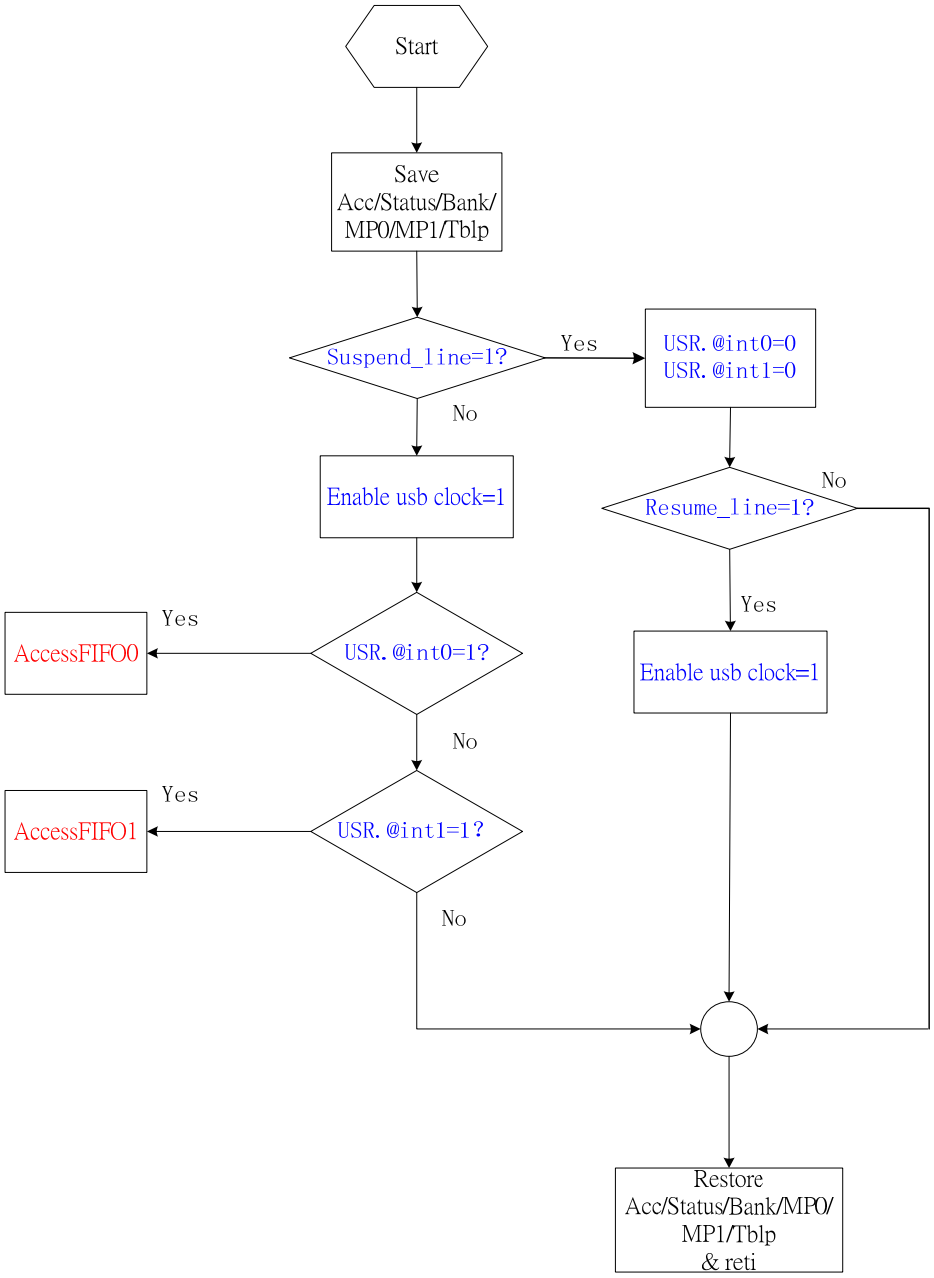
S/W Function Block Flowchart

主流程圖



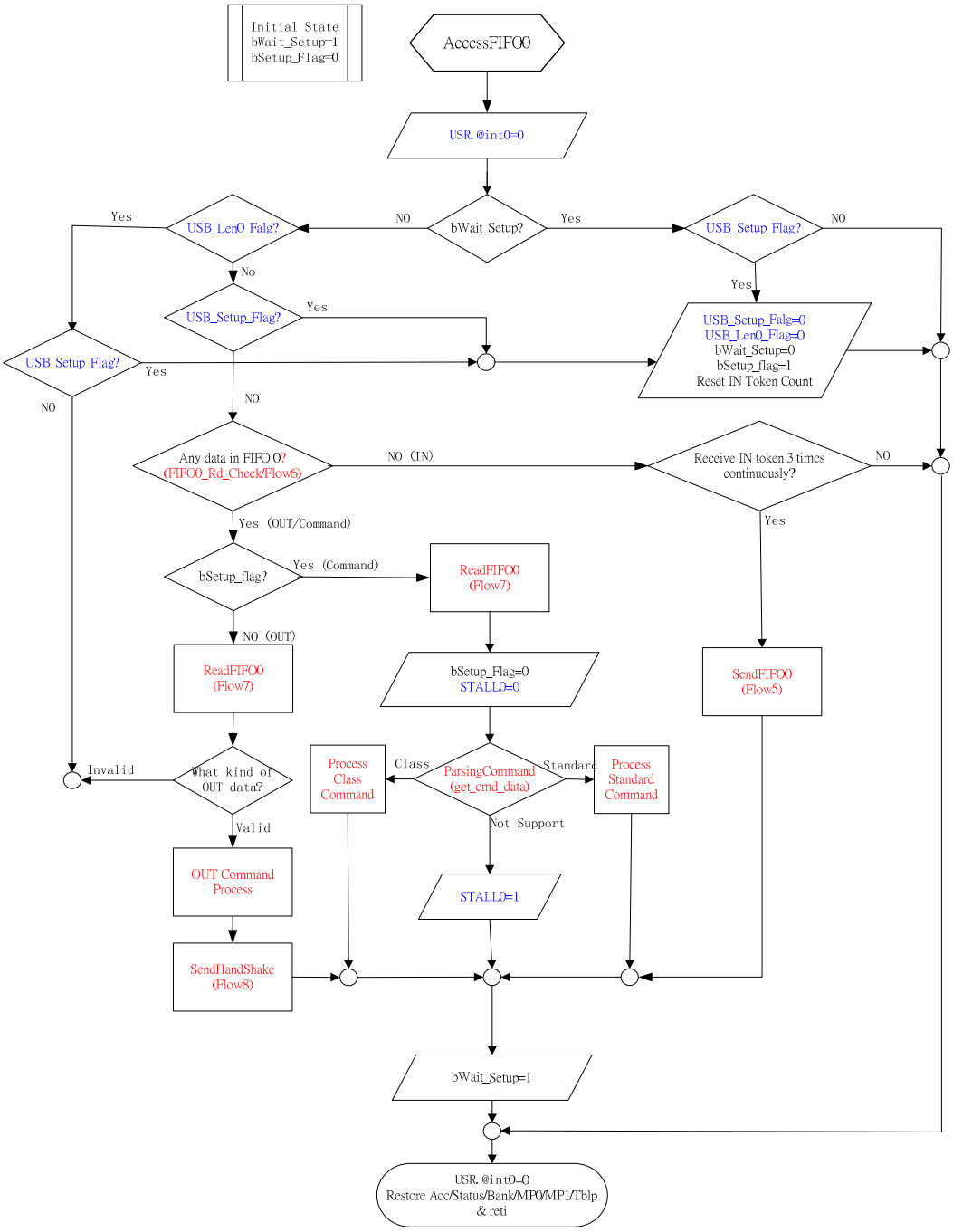
主程式主要是系統的初始化、Suspend 的檢測，當有 USB 中斷產生時進入 USB 中斷副程式；當 USB 進入 Suspend 模式時，MCU 進入 HALT 模式，當有外部中斷喚醒 MCU，打開 USB Clock，判斷是否允許 Remote Wake-up，如果允許則發送 Remote Wake-up Pulse。

USB 中斷副程式流程圖



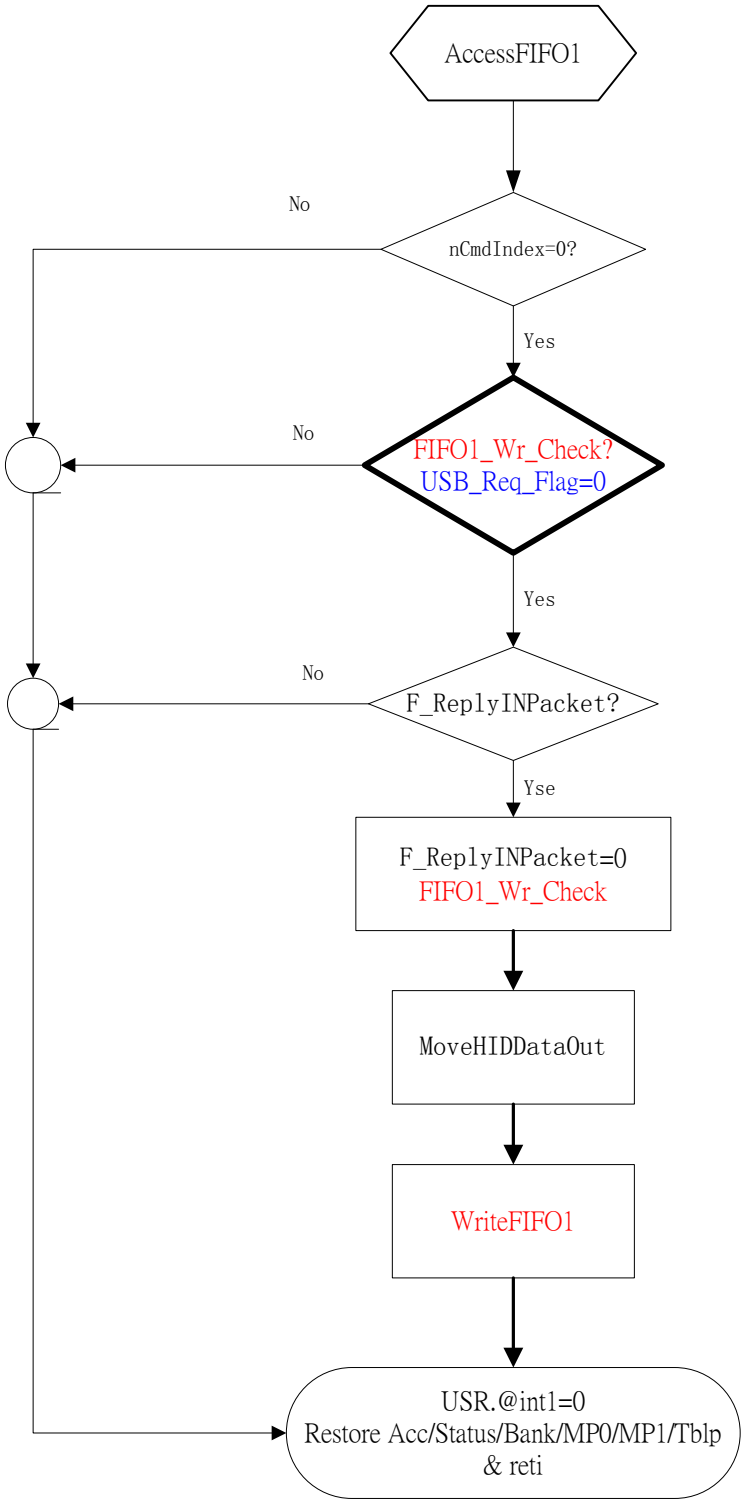
中斷副程式主要是判斷是 Suspend、Resume 引起的中斷還是存取端點產生的中斷，如果的存取中斷端點產生的中斷，則進入相應的副程式。

存取端點 0 副程式流程圖



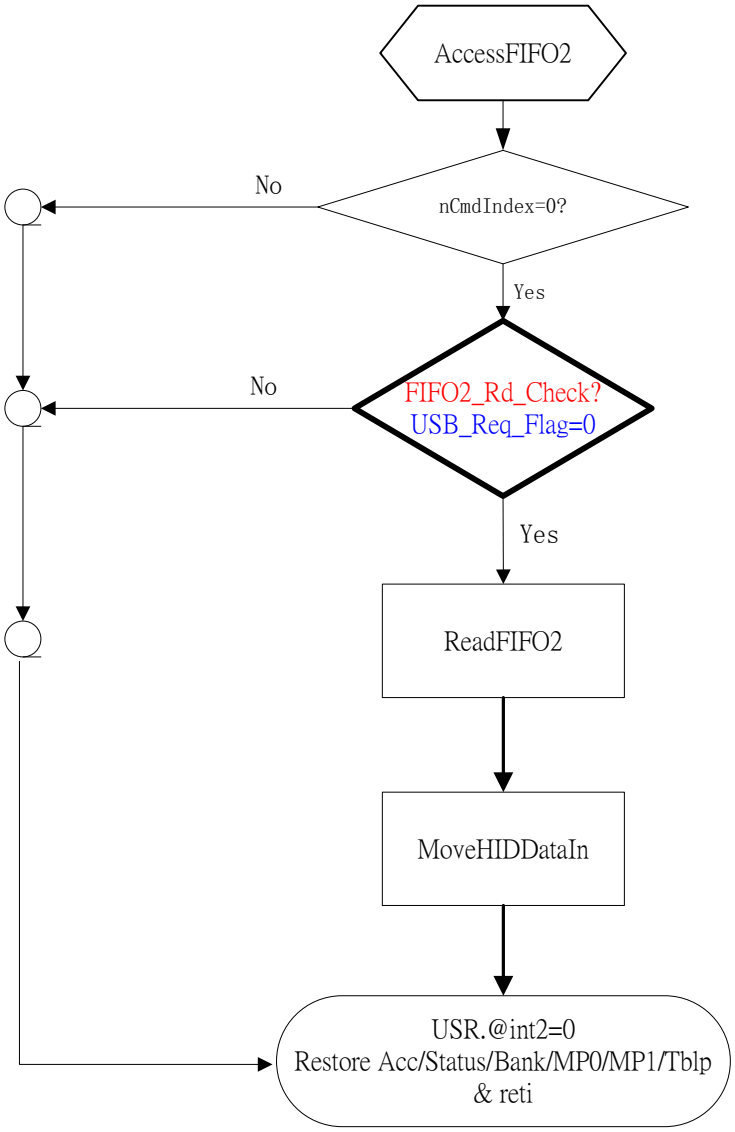
存取端點 0 副程式，主要是用於 USB 枚舉過程的，首先判斷有沒有 Setup Token，如果有，將相應旗標(bSetup_flag)設爲 1，退出中斷；如果沒有，判斷是不是 Len0 包，如果是，則退出中斷；如果不是 Setup Token 也不是 Len0 包，則先判斷 FIFO0 是否可讀(IN 或 OUT)，如果可讀(OUT)，則讀取 FIFO 的資料，若 bSetup_flag=1，代表要處理 Setup Command，再根據命令返回 HOST 所需的資料，若 bSetup_flag 不爲 1，代表是一般的 OUT Data；如果 FIFO 可寫(IN)，則發送資料。

存取端點 1 副程式流程圖



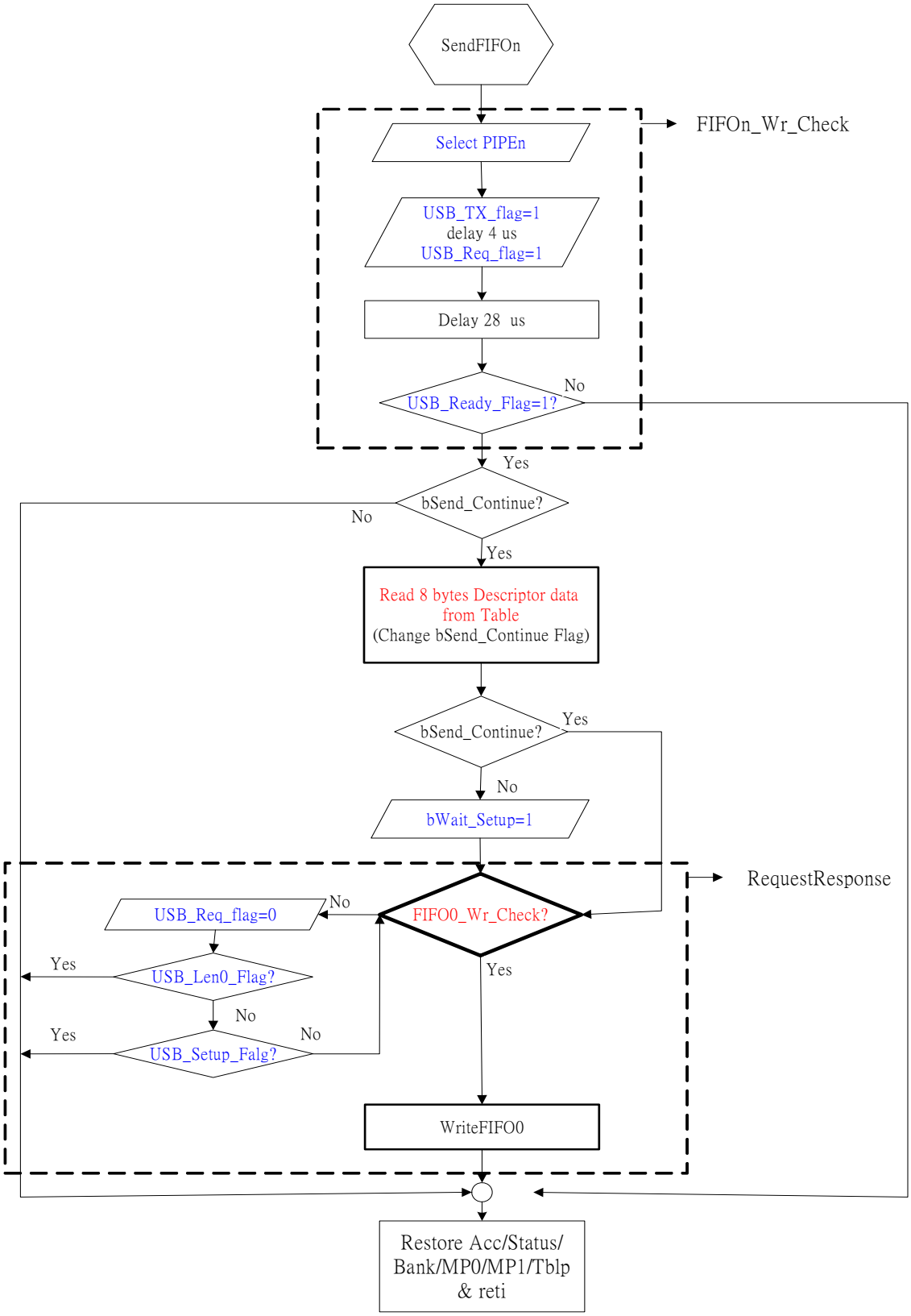
存取端點 1 副程式，主要是用來發送 8 Bytes 的資料給 PC。

存取端點 2 副程式流程圖

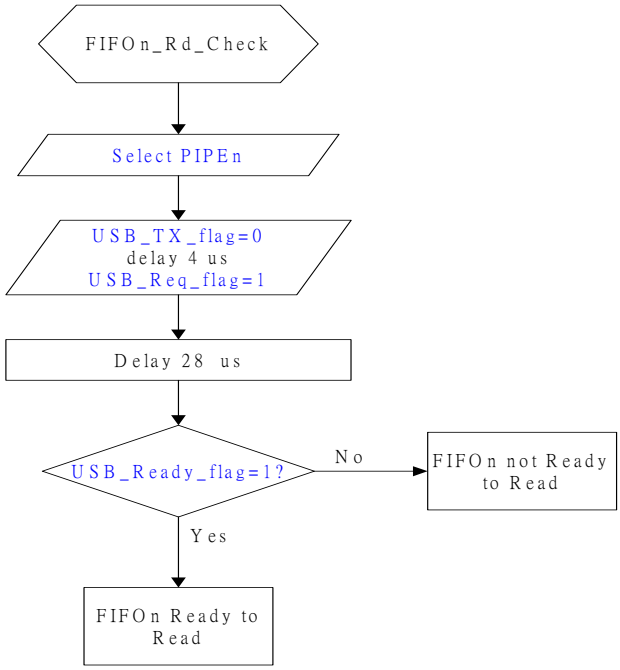


存取端點 2 副程式，主要是用來接收 PC 發過來的 8 位元組的資料。

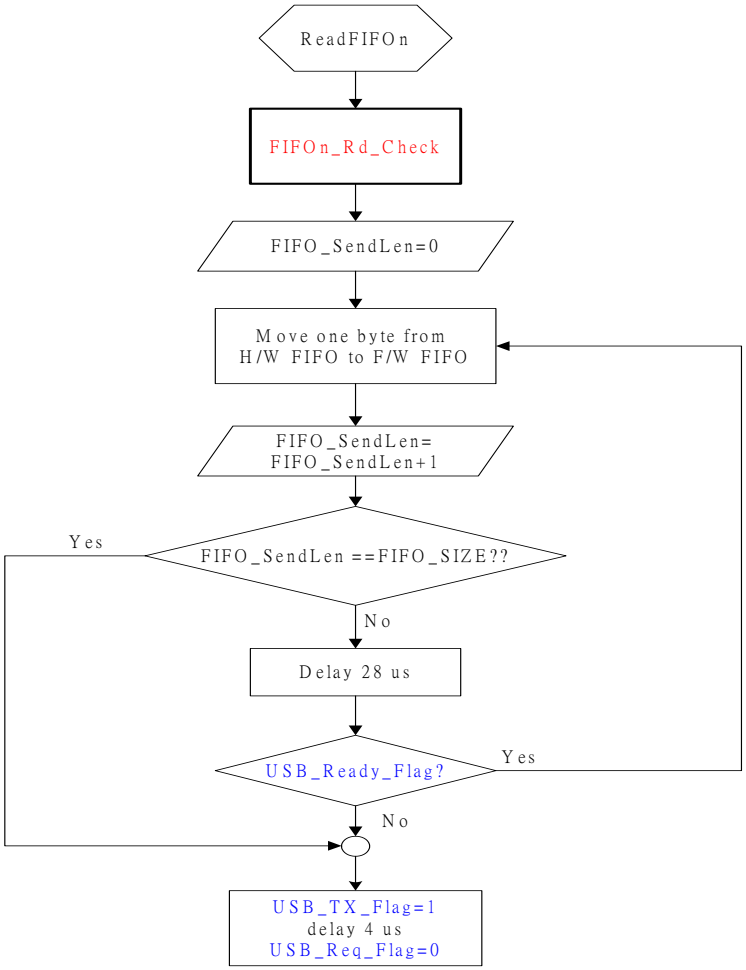
SendFIFOn 程式流程圖



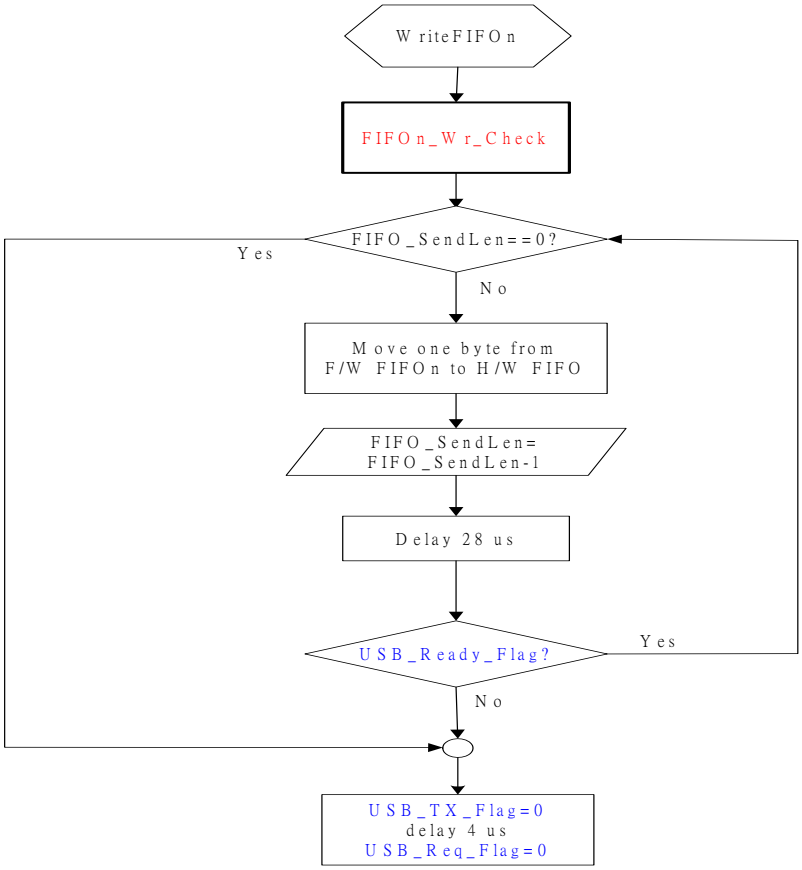
FIFO_Rd_Check 副程式流程圖



讀取 FIFO 的資料副程式流程圖



寫 FIFO 的資料副程式流程圖



文件說明

- MAIN.ASM
  該 ASM 檔中的內容爲主程式，包括暫存器和 IO 埠的初始化操作等。
- USB_INT.ASM
  該 ASM 檔中的內容爲 USB 的中斷服務程式，當發生 USB 中斷時，程式會跳到此處。
- USB_LIB.ASM
  該 ASM 檔中的內容爲對 FIFO 進行讀、寫的副程式。
- STD.ASM
  該 ASM 檔中的內容爲 USB 定義的 11 種標準 USB 請求的副程式。
- CLS.ASM
  該 ASM 檔中的內容爲 HID 設備類請求副程式。
- DES.ASM
  該 ASM 檔中的內容爲所有描述符的定義。
- Variable.ASM
  該 ASM 檔中的內容定義了 USB 功能所用到的所有變數。

Conclusions

本文通過介紹如何使用 HT82K95E 的 USB 功能來實現與 PC 端 USB 主機的 8 Bytes 的資料接收與發送。