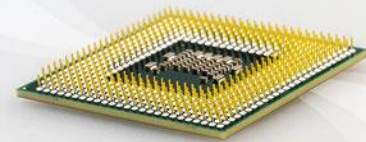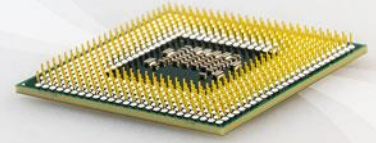# 微算機應用實習

UART

課程編號 ：EE4801702
實習課助教 ：曾子倫

Outline

- UART 介紹
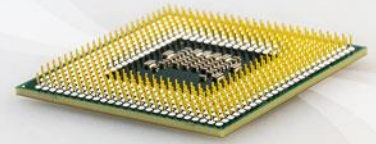
- UART 記憶體暫存器介紹

- 函式介紹

- LAB6

資料傳輸種類

- 並列(Parallel)

　　傳統加快傳輸速度的方法是把傳輸的資料拆成等份，然後以相同的傳輸路徑到另一端。但並列傳輸要加快速度，就得用更多的線路去傳，所以通常會讓排線變得很寬，速度越快也造成雜訊變多，無法拉長距離。
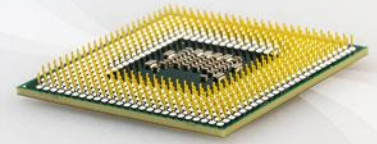
- 串列(Serial)

　　資料由單一線路傳送出去，一次傳送1個bit，資料傳出去後，藉由每個資料段標示即可在另一段組合還原。特點是線通常只要一條，可以拉很長。
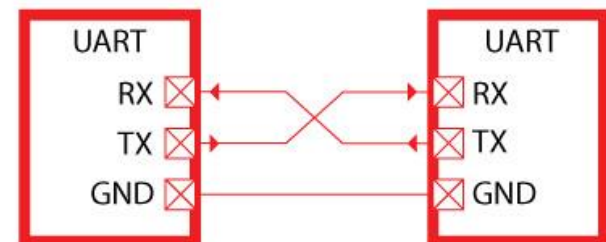
比較

- 並列(Parallel)

  速度較快、成本較高、適合短距離傳輸

  e.g.　電腦內部匯流排

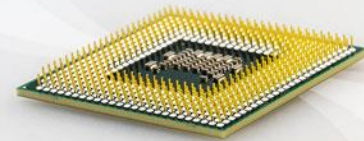- 串列(Serial)

  速度較慢、成本較低、適合長距離傳輸

  e.g.　滑鼠、鍵盤、數據機、RS232

UART 介紹

- UART
  (Universal Asynchronous Receiver/Transmitter)

- UART 是一種串列傳輸，通常會有兩條線，一條是Tx，另一條是Rx，利用這兩條線讓CPU和周邊裝置或是實驗板之間進行資料傳遞。
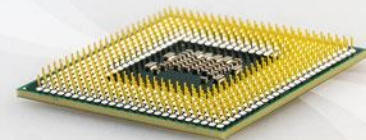
UART 介紹

- 資料格式

Start bit	1bit
Data bit	5~8bits
Parity bit	1bit
Stop bit	1bit

Tx_Bits — Start Bit / Bit0 / Bit1 / Bit2 / Bit3 / Bit4 / Bit5~7 / Parity / Stop Bit

- Baud rate（鮑率）

  資料傳輸的速度

UART 介紹

- 記憶體暫存器介紹

```c
//0:1 Start bit/8 Data bits/1 Stop bit,
#define UART_FORMAT_N81 0
//1:1 Start bit/9 Data bits/1 Stop bit
#define UART_FORMAT_N91 1

#define UART_EN              (1<<17) //0:Disable, 1:Enable
#define UART_TX_EN           (1<<15)
#define UART_RX_EN           (1<<14)
#define UART_OVER8           (1<<13)
#define UART_OVER16          (0<<13)
#define UART_WORD_LENGTH     (UART_FORMAT_N81<<12
//0:1 Start bit/8 Data bits/1 Stop bit, //1:1 Start bit/9 Data bits/1 Stop bit
#define UART_TX_DMA_EN       (1<<11) //0:Disable, 1:Enable
#define UART_RX_DMA_EN       (1<<10) // 0:Disable, 1:Enable
#define UART_RX_WAKEUP       (0<<9)  // 0:In active mode, 1:In mute mode
#define UART_WAKEUP_METHOD   (0<<8)  // 0:Idle mode, 1:Address mark
#define UART_UART_ADDR_NODE  (0x5<<4)    //Data 0x0=xxxx0000b ~ 0xF=xxxx1111b,
#define UART_PARITY_EN       (0<<2)//SET_BIT1//(n<<1) //0:Disable, 1:Enable
#define UART_PARITY_SEL      (1<<1)// O:Even 1:Odd
#define UART_STOP_BIT   0// O:1-bit 1:2-bit

#define UART_SET_CTL_PARA     UART_EN|UART_TX_EN|UART_RX_EN|UART_WORD_LENGTH\
                              |UART_RX_WAKEUP|UART_WAKEUP_METHOD|UART_UART_ADDR_NODE\
                              |UART_PARITY_EN|UART_PARITY_SEL|UART_STOP_BIT
```

UART 介紹
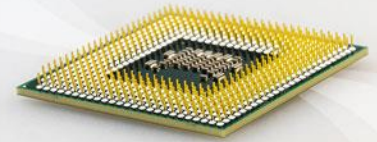
- UART_CTL

Index	Default	R/W	Bit	Name	Description
00			31:18	Reserved	
	0	R/W	17	UE	UART enable 0: UART prescaler and outputs disabled 1: UART enabled
	0		16	reserved	
	0	R/W	15	TE	Transmitter enable

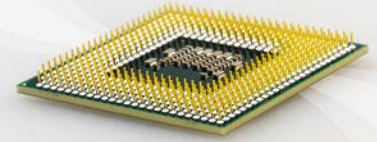| Index	Default	R/W	Bit	Name	Description
					0: Transmitter is disabled 1: Transmitter is enabled
	0	R/W	14	RE	Receiver enable 0: Receiver is disabled 1: Receiver is enabled and begins searching for a start bit
	0	R/W	13	OVER8	Over sampling mode 0: over sampling by 16 1: over sampling by 8 Note: Over sampling by 8 is not available in IrDA, LIN mode, when IREN.
	0	R/W	12	M	Word length 0: 1 Start bit, 8 Data bits, n Stop bit 1: 1 Start bit, 9 Data bits, n Stop bit
	0	R/W	11	DMAT	DMA enable transmitter 1: DMA mode is enabled for transmission 0: DMA mode is disabled for transmission

UART 介紹
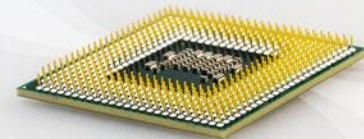
- UART_CTL

0	R/W	10	DMAR	DMA enable receiver 1: DMA mode is enabled for reception 0: DMA mode is disabled for reception
0	R/W	9	RWU	Receiver wakeup 0: Receiver in active mode 1: Receiver in mute mode
0	R/W	8	WAKE	Wakeup method 0: Idle Line 1: Address Mark
0	R/W	7:4	ADDR[3:0]	Address of the UART node This bit-field gives the address of the USART node.
0	R/W	3		Reserved
0	R/W	2	PCE	Parity control enable 0: disable 1: enable
0	R/W	1	PS	Parity selection 0: Even 1: Odd
0	R/W	0	STOP	0: STOP = 1bit 1: STOP = 2bit

UART 介紹

- Baud Rate_CTL

Baud Rate Register

Index	Default	R/W	Bit	Name	Description
14			31:16	Reserved	
	0	R/W	15:4	Mantissa[11:0]	mantissa of Baud Rate Generator
	0	R/W	3:0	Fraction[3:0]	fraction of Baud Rate Generator

- 定義Baud Rate 相關參數

```
#define  BUARRATE_38400_MANTISSA_24MHZ    39
#define  BUARRATE_38400_FRACTION_24MHZ    1
```
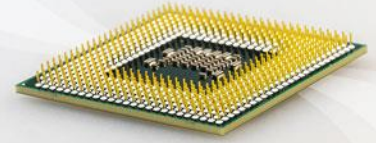
UART 介紹

- Baud Rate 計算

$$\text{Baud rate} = \cfrac{Sysclk}{8 * (2 - OVER8) * (Mantissa + \cfrac{Franction}{16})}$$

目前設定

$$38400 = \cfrac{12M}{8 * (2 - 0) * (39/2 + \cfrac{1}{16}/2)}$$

硬體架構

PC10 ────────────── **»** S1_TXD 7
PC11 ────────────── **«** S1_RXD 7
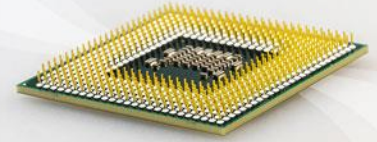
UART

函式介紹

- 函式介紹

函式名稱	函式功能
DRV_Printf( )	將資料透過 UART 傳輸

函式介紹
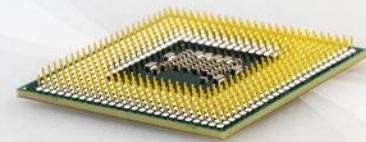
- DRV_Printf( )

  字元　%C, %c

  ```
  char a='a';
  DRV_Printf("%c\r\n", a);
  ```

  整數　%d, %i

  ```
  int number=56320;
  DRV_Printf("%d\r\n", number);
  ```

  16進制 %X, %x

  ```
  char a='a';
  DRV_Printf("%x\r\n", a);
  ```

函式介紹
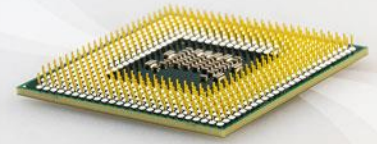
- DRV_Printf( )

```c
void DRV_Printf(char *pFmt, U16 u16Val)
{
    U8 u8Buffer;

    //-----Pin configuration for UART3
    GPIO_PTC_FS = 0x0300;
    GPIO_PTC_PADINSEL = 0x0000;
    GPIO_PTC_DIR = 0xFEFF;
    GPIO_PTC_CFG = 0x0000;

    //UART Parameter
    OUTW(UART3_ADDR_BASE+0x00, UART_SET_CTL_PARA);

    //Set Baud rate with default sysclk
    OUTW(UART3_ADDR_BASE+0x14, ((BUARRATE_38400_MANTISSA_24MHZ<<4)|BUARRATE_38400_FRACTION_24MHZ)/2);
    //38400 for 12MHz MCUCLK
```

函式介紹
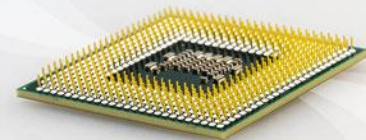
- DRV_Printf( )

```c
while((u8Buffer =(U8)*(pFmt++)))
{
    if(u8Buffer == '%') //check special case
    {
        switch(*(pFmt++)) //check next character
        {
            case 'x': //hexadecimal number
            case 'X':
                DRV_IntToStr(u16Val, 16, u8TxdBuf, 2);
                DRV_PutStr(u8TxdBuf);
            break;
            case 'd': //decimal number
            case 'i':
                DRV_IntToStr(u16Val, 10, u8TxdBuf,5);
                DRV_PutStr(u8TxdBuf);
            break;
            case 'c':
            case 'C':
                DRV_PutChar((char)u16Val);
            break;
        } //switch
    }
    else //general
    {
        DRV_PutChar(u8Buffer); //put a character
    }
}
```
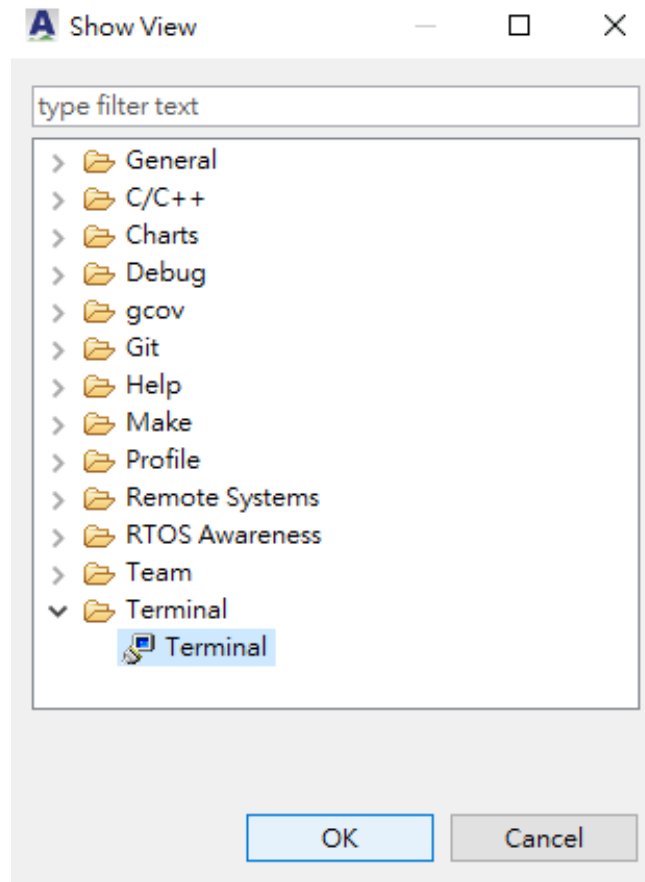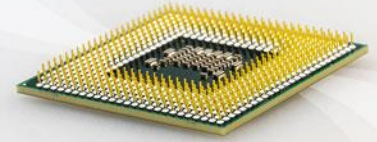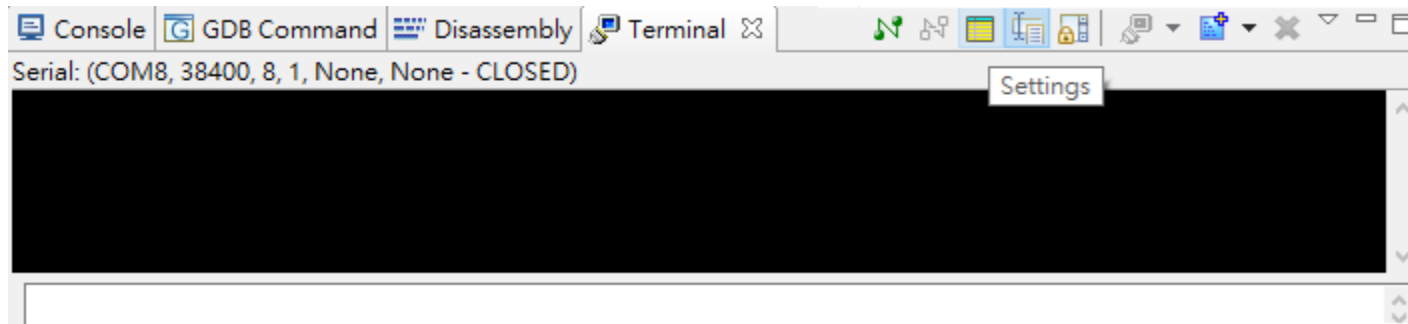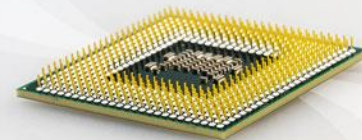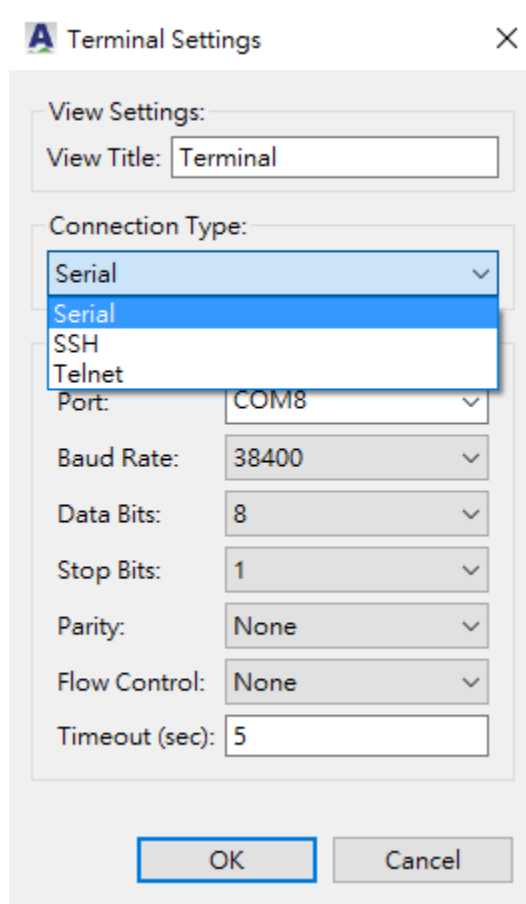
開啟終端機
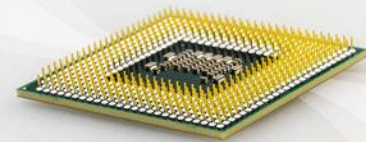
- 點選工具列的Window→Show View→Other
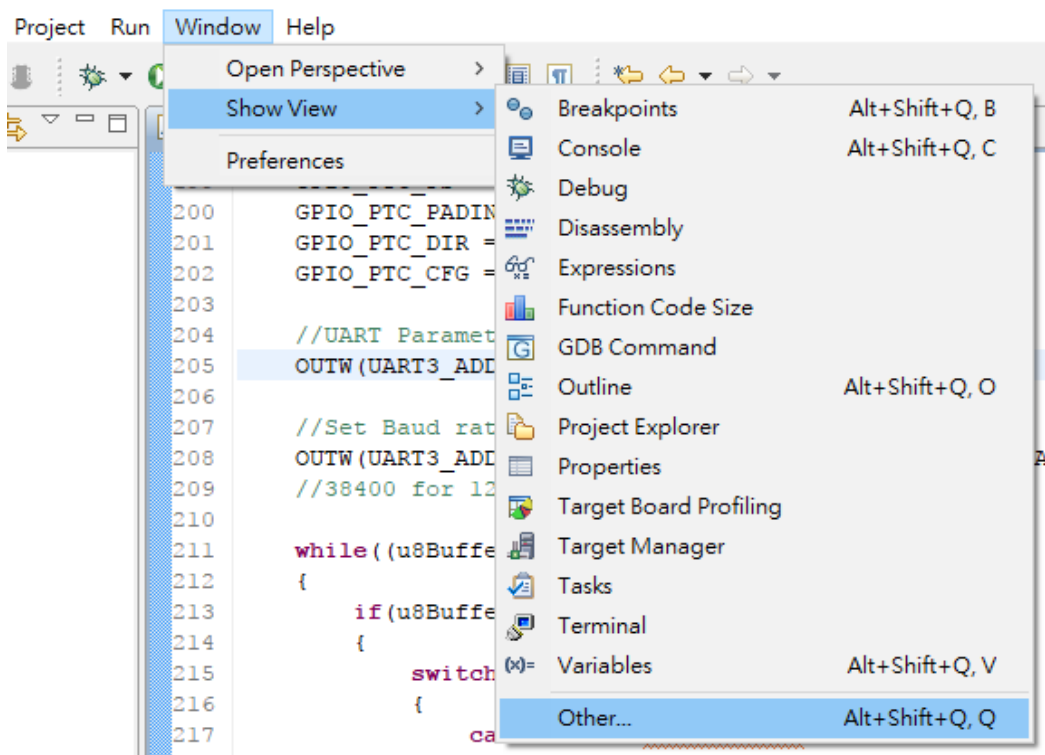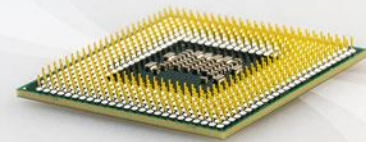
開啟終端機
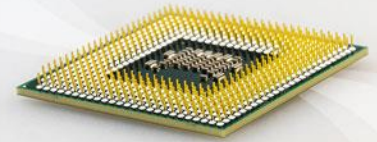
- 點選Terminal → OK
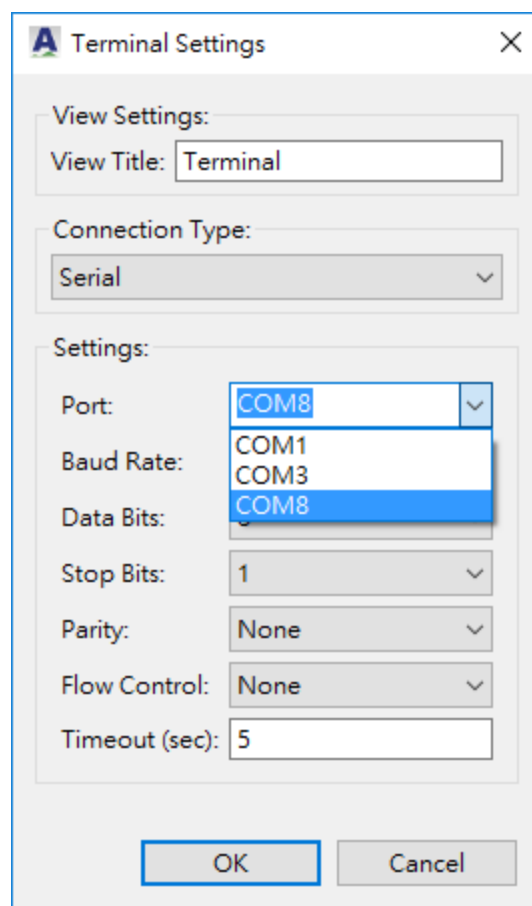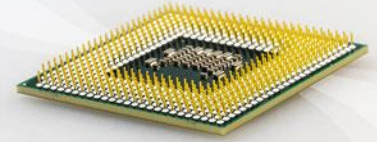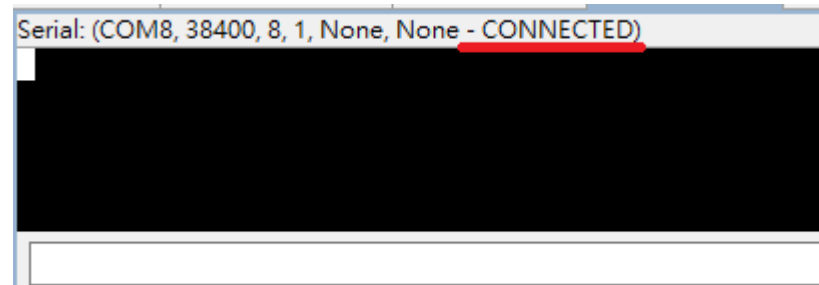
開啟終端機

- 點選Settings

開啟終端機

- 點選Connection Type → Serial

開啟終端機

- 點選Port → Comx（請自行到裝置管理員確認）

開啟終端機

- 顯示CONNECTED即OK

Serial: (COM8, 38400, 8, 1, None, None - CONNECTED)
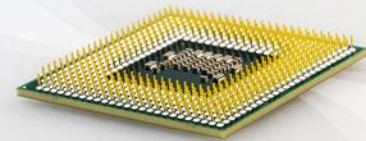
Example

- 用UART傳送字串到終端機並顯示在螢幕上

```c
int main()
{
    OS_PowerOnDriverInitial();

    int   number=65530;
    char a='a';
    char string[]="====================================\r\n";   //Print string
    DRV_Printf("   ADP-WT58F2C9 UART demo program   \r\n", 0);  //Print string
    DRV_Printf("   Default baud rate: 38400 8-n-1\r\n", 0);     //Print string
    DRV_Printf(string, 0);                                      //Print string

    DRV_Printf("%d\r\n", number);   //Print integer
    DRV_Printf("%c\r\n", a);        //Print character
    DRV_Printf("%x\r\n", a);        //Print ascii

    return 0;
}
```

LAB6
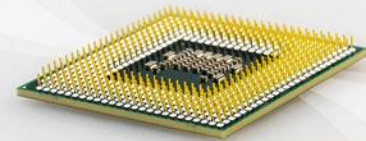
- 請先將RTC初始化到"當前時間"，並利用UART傳送至終端機每秒顯示一次

```
UART LAB
09:59:59
10:00:00
10:00:01
10:00:02
10:00:03
10:00:04
10:00:05
10:00:06
10:00:07
10:00:08
10:00:09
10:00:10
10:00:11
10:00:12
10:00:13
```