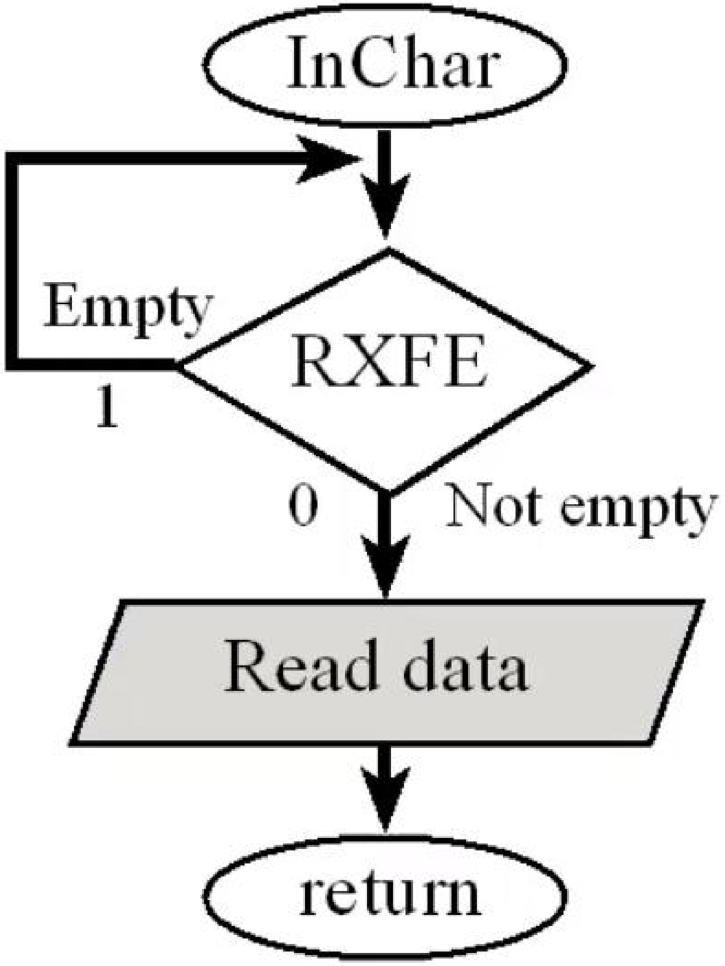
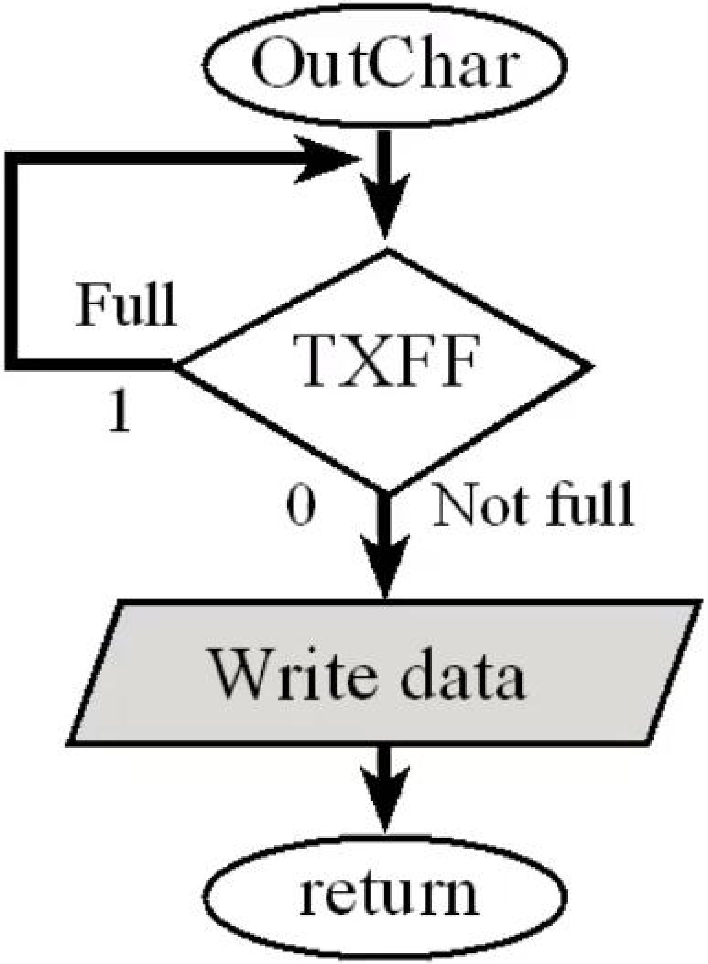
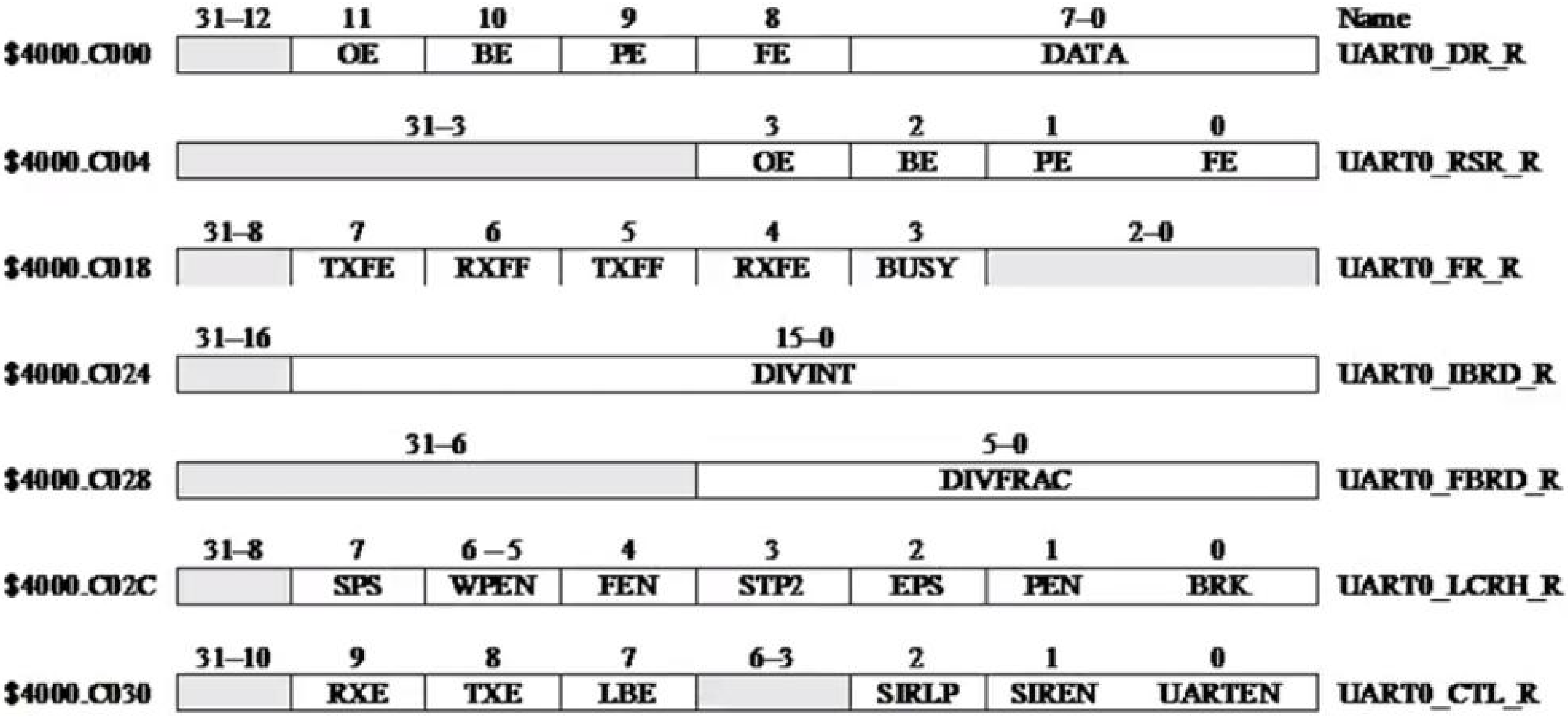
UART Synchronization

- Busy-wait operation





TM4C UART0 – Registers



	31–12	11	10	9	8	7–0	Name
$4000.C000		OE	BE	PE	FE	DATA	UART0_DR_R

	31–3	3	2	1	0	
$4000.C004		OE	BE	PE	FE	UART0_RSR_R

	31–8	7	6	5	4	3	2–0	
$4000.C018		TXFE	RXFF	TXFF	RXFE	BUSY		UART0_FR_R

	31–16	15–0	
$4000.C024		DIVINT	UART0_IBRD_R

	31–6	5–0	
$4000.C028		DIVFRAC	UART0_FBRD_R

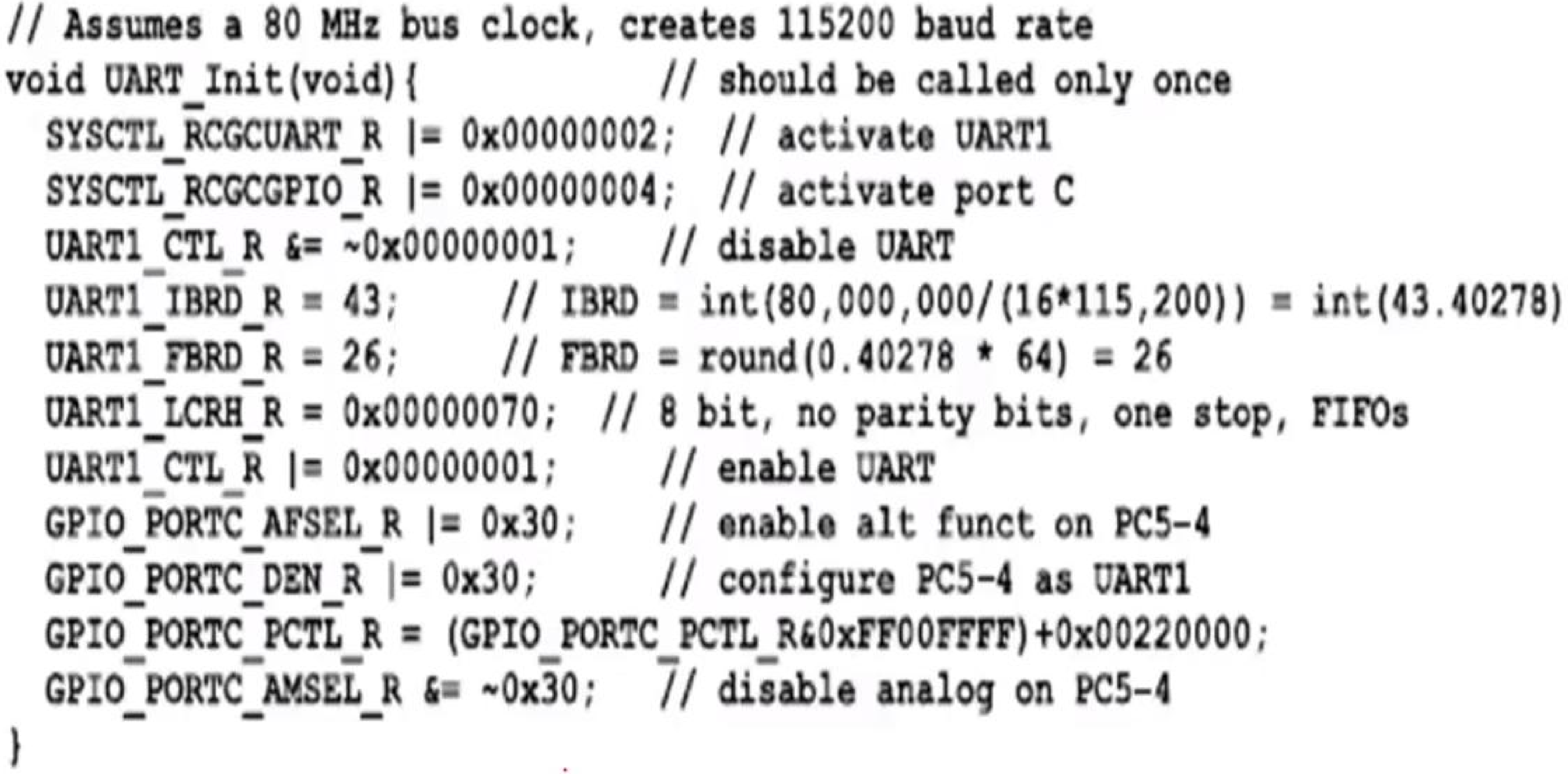
	31–8	7	6 – 5	4	3	2	1	0	
$4000.C02C		SPS	WPEN	FEN	STP2	EPS	PEN	BRK	UART0_LCRH_R

	31–10	9	8	7	6–3	2	1	0	
$4000.C030		RXE	TXE	LBE		SIRLP	SIREN	UARTEN	UART0_CTL_R

TM4C UART Setup

- UART0 operation
  - UART clock started in **SYSCTL_RCGCUART_R**
  - Digital port clock started in **SYSCTL_RCGCGPIO_R**
  - **UART0_CTL_R** contains UART enable (UARTEN), Tx (TXE), and Rx enable (RXE)
    - set each to 1 to enable
    - **UART disabled during initialization**
  - **UART1_IBRD_R** and **UART1_FBRD_R** specify baud rate
    - bit rate = (bus clock frequency)/(16*divider)
    - ex: want 19.2 kb/s and bus clock is 80 MHz
    - 80 MHz/(16*19.2 k) = 26.04167 = 11010.000011_2
    - Tx and Rx clock rates must be within 5% to avoid errors
  - **GPIO_PORTC_AFSEL_R** to choose alternate function
  - **GPIO_PORTC_DEN_R** Enable digital I/O on pins 1-0
  - **GPIO_PORTC_AMSEL_R** no Analog I/O on pins 1-0
  - **write to UART0_LCRH_R to activate**

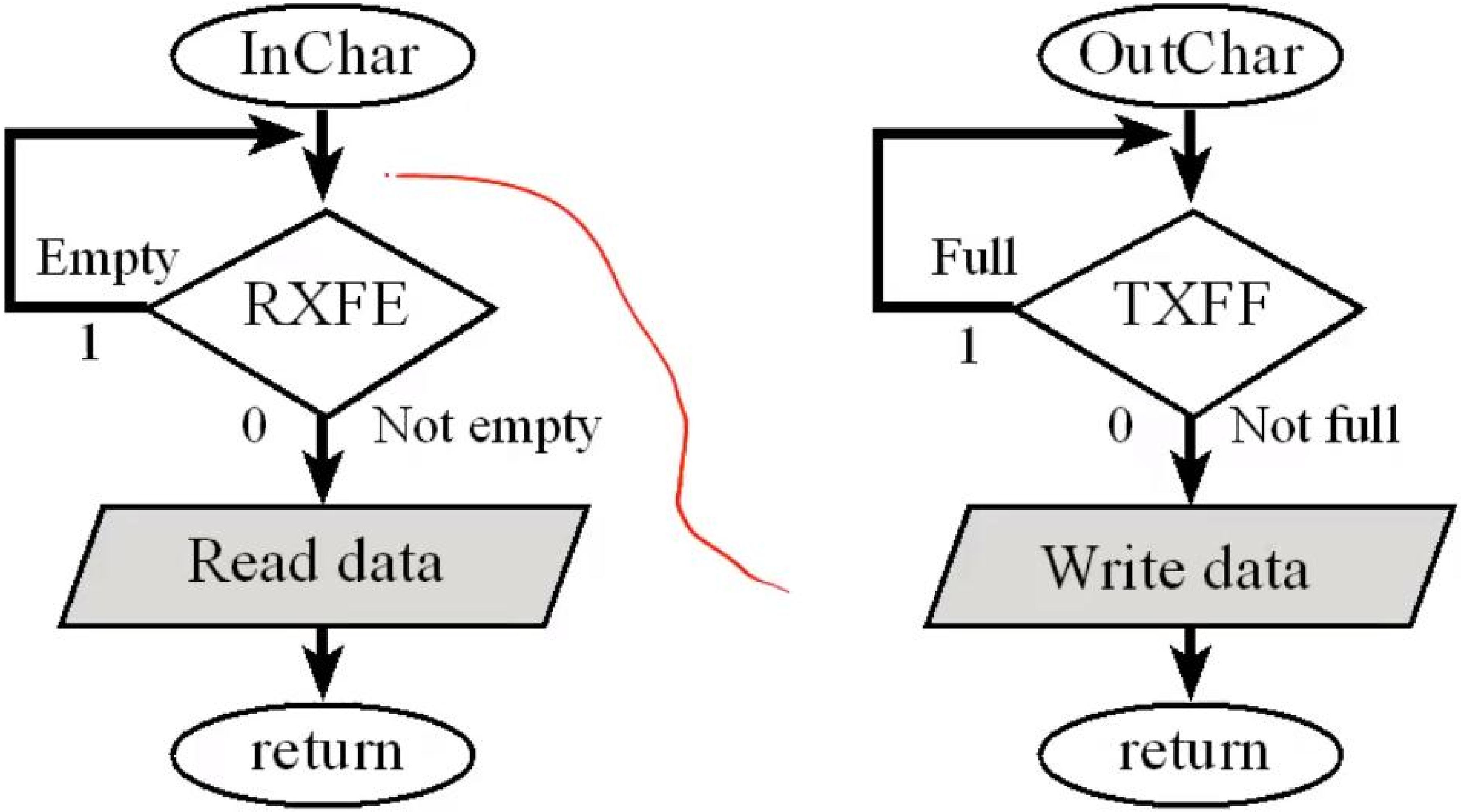
TM4C UART Programming



```
// Assumes a 80 MHz bus clock, creates 115200 baud rate
void UART_Init(void){                   // should be called only once
  SYSCTL_RCGCUART_R |= 0x00000002;  // activate UART1
  SYSCTL_RCGCGPIO_R |= 0x00000004;  // activate port C
  UART1_CTL_R &= ~0x00000001;       // disable UART
  UART1_IBRD_R = 43;        // IBRD = int(80,000,000/(16*115,200)) = int(43.40278)
  UART1_FBRD_R = 26;        // FBRD = round(0.40278 * 64) = 26
  UART1_LCRH_R = 0x00000070;  // 8 bit, no parity bits, one stop, FIFOs
  UART1_CTL_R |= 0x00000001;        // enable UART
  GPIO_PORTC_AFSEL_R |= 0x30;       // enable alt funct on PC5-4
  GPIO_PORTC_DEN_R |= 0x30;         // configure PC5-4 as UART1
  GPIO_PORTC_PCTL_R = (GPIO_PORTC_PCTL_R&0xFF00FFFF)+0x00220000;
  GPIO_PORTC_AMSEL_R &= ~0x30;      // disable analog on PC5-4
}
```

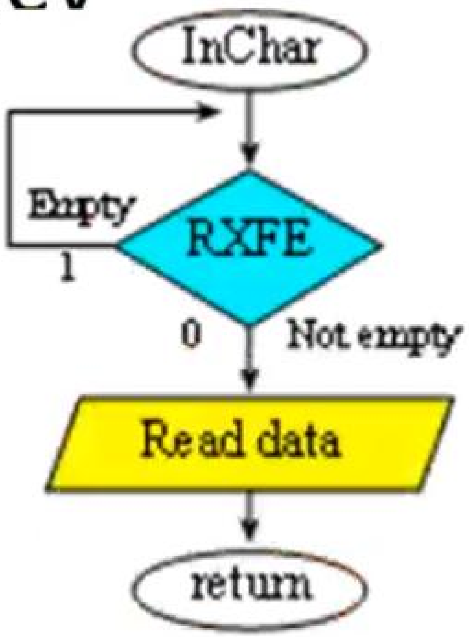
UART Synchronization

- Busy-wait operation

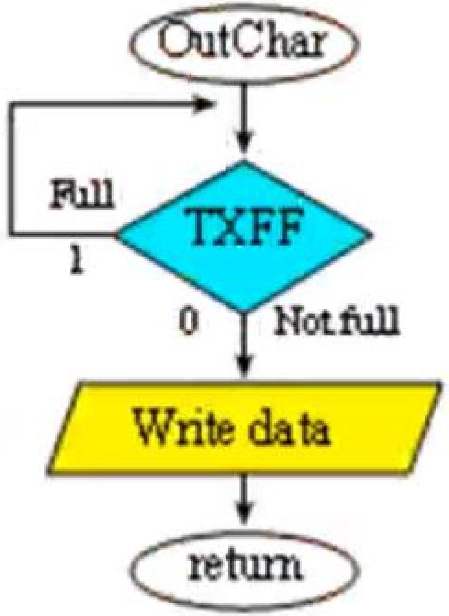


UART Busy-Wait Send/Recv

```
// Wait for new input,
// then return ASCII code
uint8_t UART_InChar(void) {
  while((UART1_FR_R&0x0010) != 0);
  // wait until RXFE is 0
  return((uint8_t)(UART1_DR_R&0xFF));
}
```



```
// Wait for buffer to be not full,
// then output
void UART_OutChar(uint8_t data) {
  while((UART1_FR_R&0x0020) != 0);
  // wait until TXFF is 0
  UART1_DR_R = data;
}
```


OutChar
Full
1
TXFF
0
Not full
Write data
return