BECE204P-Microprocessors & Microcontrollers Lab
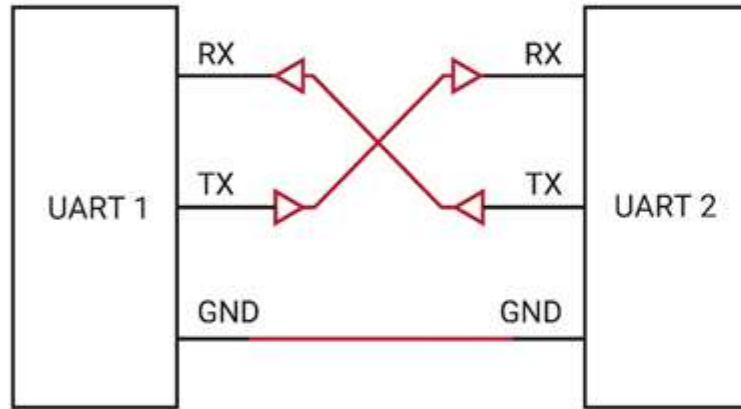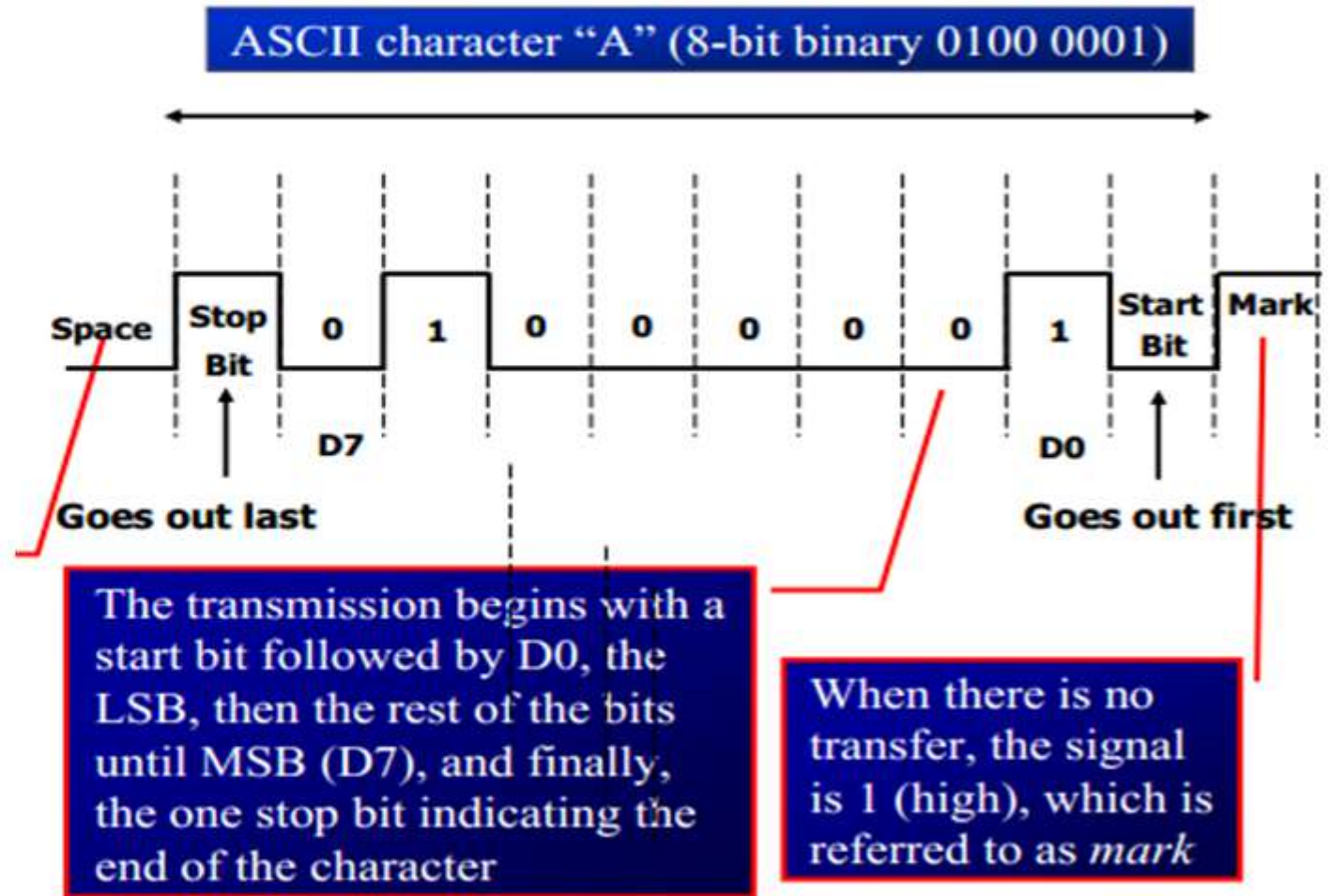
LAB-10
SERIAL PORT PROGRAMMING IN 8051

SERIAL COMMUNICATION

➢ In data transmission, serial communication is the process of sending data one bit at a time, sequentially, over a communication channel or computer bus. Ex: UART, USART, SPI, I²C etc.,

➢ There are special IC chips made by many manufacturers for serial communications

  - UART (universal asynchronous Receiver-transmitter)
  - USART (universal synchronous-asynchronous Receiver-transmitter)

➢ 8051 has one UART in which two pins (11 and 10) are used specifically for transferring (Tx) and receiving (Rx) data serially as a part of the port 3 group (P3.1 and P3.0).

➢ To allow data transfer between two UART devices, ensure the baud rate of both devices matches. Different baud rate levels are, 600, 1200, 2400, 4800, 9600, 19200 etc.,

➢ The rate of data transfer in serial data communication is stated in bps(bits per second). The baud rate and bps are the same, used inter changeably.

SERIAL COMMUNICATION

ASCII character "A" (8-bit binary 0100 0001)

Wiring Connection between two UART

Space | Stop Bit | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | Start Bit | Mark

D7 ... D0

Goes out last

Goes out first

The transmission begins with a start bit followed by D0, the LSB, then the rest of the bits until MSB (D7), and finally, the one stop bit indicating the end of the character

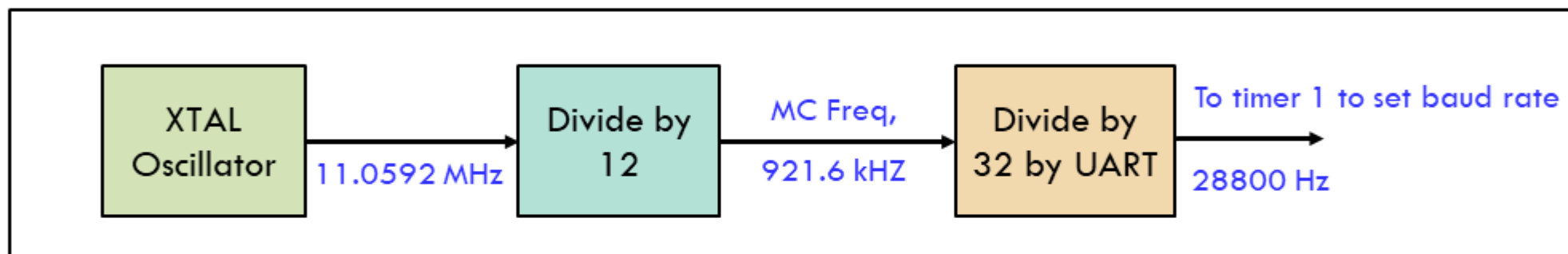When there is no transfer, the signal is 1 (high), which is referred to as *mark*

Serial communication message format

SERIAL COMMUNICATION

BAUD RATE GENERATION IN 8051

➤ Dividing 1/12 of the crystal frequency by 32 is the default frequency (28800 Hz) for timers to generate the baud rate.

➤ With XTAL=11.0592 MHz, find the TH1 value needed to set different baud rate.

- 28800/3 = 9600   Where -3=FD (hex) is loaded into TH1

- 28800/6 = 4800   Where -6=FA (hex) is loaded into TH1

- 28800/12 = 2400   Where -12=F4 (hex) is loaded into TH1

- 28800/24 = 1200   Where -24=E8 (hex) is loaded into TH1

SERIAL COMMUNICATION

➢ Register required to work with 8051 serial communications are: SBUF and SCON

➢ SBUF is an 8-bit register used to hold a data during transmit and receive operation

        MOV SBUF, #'D'   ; load SBUF=44H, ASCII for 'D'
        MOV SBUF, A   ; copy Accumulator into SBUF
        MOV A, SBUF   ; copy SBUF into Accumulator

➢ SCON is an 8-bit the special function register (bit-addressable).

➢ This register contain not only the mode selection bits but also the 9th data bit for transmit and receive (TB8 and RB8) and the serial port interrupt bits (TI and RI).

SMO	SM1	SM2	REN	TB8	RB8	TI	RI

SERIAL COMMUNICATION

BIT	NAME	DESCRIPTION
7	SM0	Serial port mode bit 0
6	SM1	Serial port mode bit 1
5	SM2	Multi processor communication enable bit
4	REN	Receiver Enable. This bit is set in order to receive characters.
3	TB8	Transmit bit 8. The 9th bit to transmit in mode 2 and 3.
2	RB8	Recieve bit 8. The 9th bit to receive in mode 2 and 3.
1	TI	Transmit Interrupt Flag. Set when a byte has been completely transmitted.
0	RI	Receive Interrupt Flag. Set when a byte has been completely Received.

SM0	SM1	MODE	DESCRIPTION	BAUD RATE
0	0	0	Shift register: Serial data are transmitted and received through the RXD pin, while the TXD pin output clocks	$F_{osc.}/12$
0	1	1	8-Bit UART: 8-bit DATA, 1-bit for START, 1-bit for STOP	Variable
1	0	2	9-Bit UART: 9-bit DATA, 1-bit for START, 1-bit for STOP	$F_{osc.}/64$ or $F_{osc.}/32$
1	1	3	9-Bit UART: 9-bit DATA, 1-bit for START, 1-bit for STOP	Variable

SERIAL COMMUNICATION

STEP TO PROGRAM 8051 TO TRANSFER CHARACTER BYTES SERIALLY

1. Load TMOD with 20H, indicating the use of timer 1 in mode 2 (8-bit auto-reload) to set baud rate

2. The TH1 is loaded with one of the values to set baud rate for serial data transfer

3. Load SCON with 50H, indicating mode 1, where an 8-bit data is framed with start and stop bits

4. TR1 is set to 1 to start timer 1

5. The character byte to be transferred serially is written into SBUF register

6. The TI flag bit is monitored using JNB TI, xx to check the character is transferred completely or not

7. TI is cleared by CLR TI instruction

8. To transfer the next byte, go to step 5

Write a program for the 8051 to transfer a message "Welcome!" serially at 4800 baud rate continuously using DB and DPTR instructions.

```
                ORG 0000H               ;starting position
MAIN:           MOV TMOD, #20H          ;timer1,mode 2(auto reload)
                MOV TH1,#0FDH           ; 9600 baud rate
                MOV SCON, #50H          ;8-bit, 1 stop, REN enabled
                SETB TR1                ; start timer
REPEAT:         MOV DPTR, #MESSAGE      ; Load starting address of the text to be transmitted
NEXT:           CLR A                   ; Initialize Accumulator with 00H
                MOVC A, @A+DPTR         ; read the value; check for end of line
                JZ REPEAT               ; check for end of line
                MOV SBUF, A             ; place the value in SBUF
HERE:           JNB TI, HERE            ; wait until transmit complete
                CLR TI                  ; clear TI
                INC DPTR                ; move to next value
                SJMP NEXT               ; repeat
MESSAGE:        DB 'Welcome!',0         ; Message to be transmitted
                END
```

SERIAL COMMUNICATION

STEP TO PROGRAM 8051 TO RECEIVE CHARACTER BYTES SERIALLY

1. Load TMOD with 20H, indicating the use of timer 1 in mode 2 (8-bit auto-reload) to set baud rate

2. The TH1 is loaded with one of the values to set baud rate for serial data transfer

3. Load SCON with 50H, indicating mode 1, where an 8-bit data is framed with start and stop bits

4. TR1 is set to 1 to start timer 1

5. The RI flag bit is monitored using JNB RI, xx to check the character is received completely or not

6. If RI is raised, SBUF register has a byte and transfer it to accumulator

7. RI is cleared by CLR RI instruction

8. To transfer the next byte, go to step 5

Write a program for the 8051 to receive bytes of data serially, and put them in P1, set the baud rate at 4800, 8-bit data, and 1 stop bit.

```
              ORG 0000H
              MOV P1,#00H
              MOV TMOD,#20H        ;timer1,mode 2(auto reload)
              MOV TH1,#-6           ;4800 baud rate -6=FAH
              MOV SCON,#50H        ;8-bit, 1 stop, REN enabled
              SETB TR1             ;start timer 1
HERE:         JNB RI,HERE          ;wait for char to come in
              MOV A,SBUF           ;saving incoming byte in A
              MOV P1,A             ;send to port 1
              CLR RI               ;get ready to receive next byte
              SJMP HERE            ;keep getting data
```

Assume a switch is connected to pin P1.7. Write an 8051 program to monitor its status and send two messages to serial port continuously as follows. Assume XTAL = 11.0592 MHz, 9600 baud, 8-bit data, and 1 stop bit.

* SW=0 send "(Your Reg. No)"
* SW=1 send "(Your short name)"