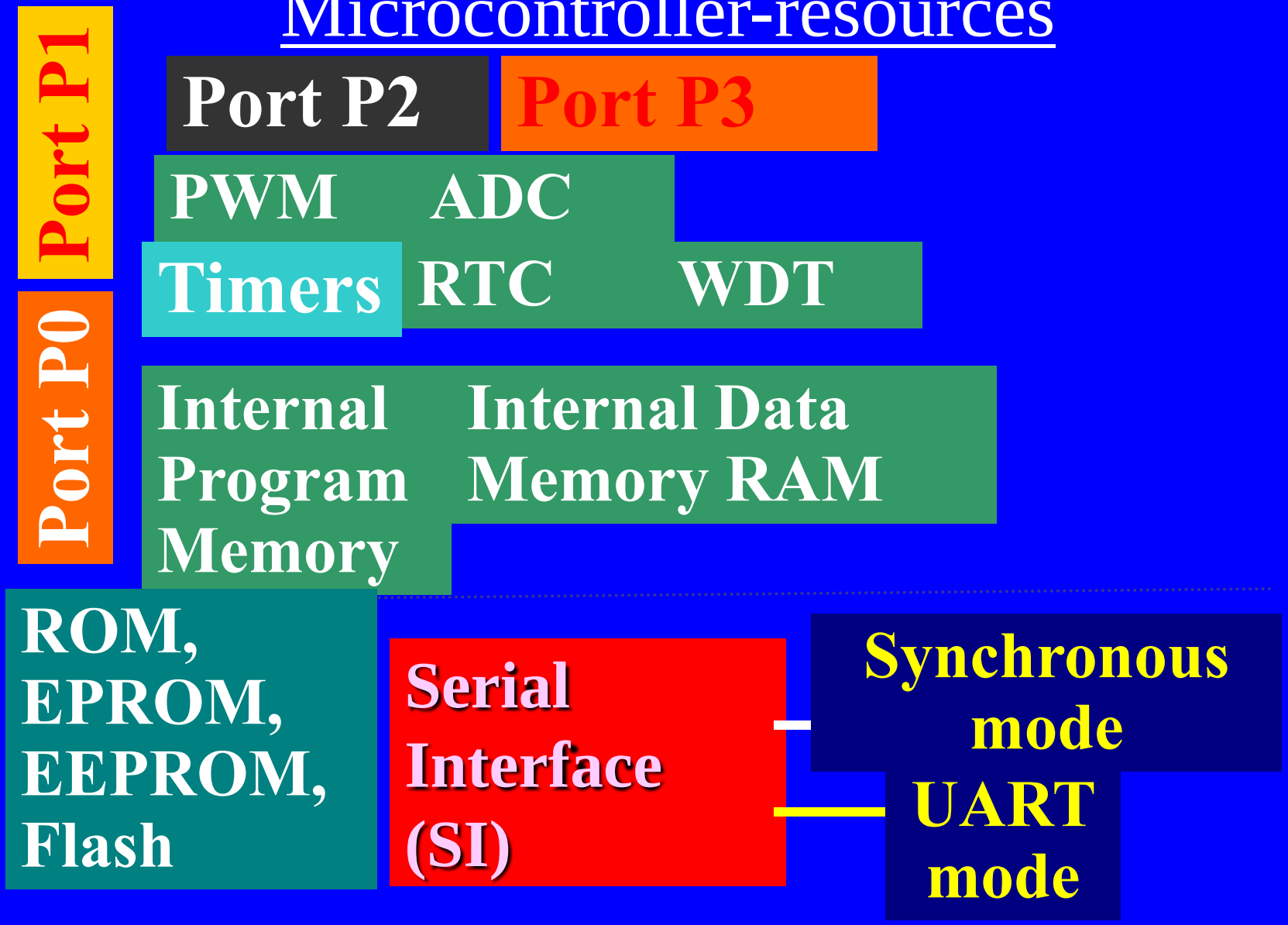
Chapter 2

Overview of Architecture and Microcontroller-Resources

Lesson 5

Synchronous and Asynchronous—Serial Communication

Microcontroller-resources

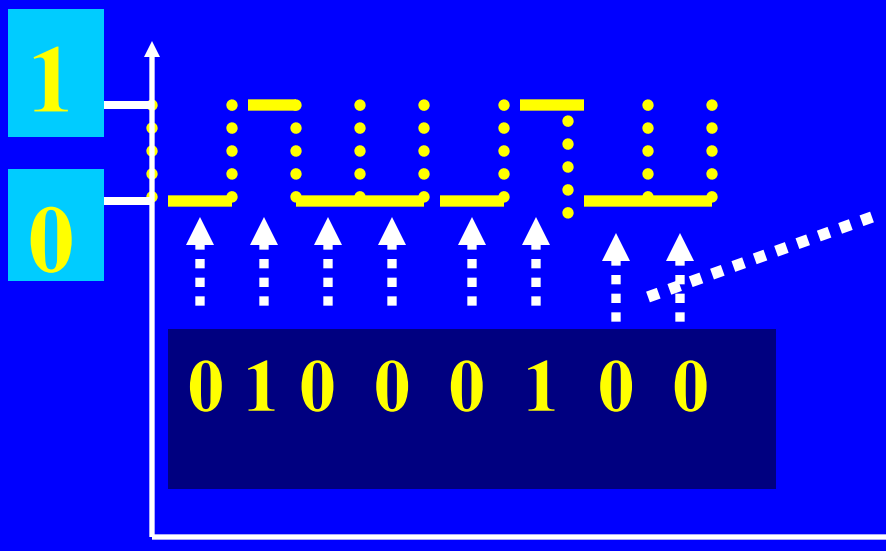


Serial Communication

Serial Transmission

- For each character or byte, in place of 8 bits simultaneously to a port, a stream of 1s and 0s is sent at prefixed intervals on a data line or port, called serial data line or serial port
- Interval = T, Serial Bits transmission rate = T^{-1} bps (bit per sec).

Serial Transmitter output 8 bits (01000100)

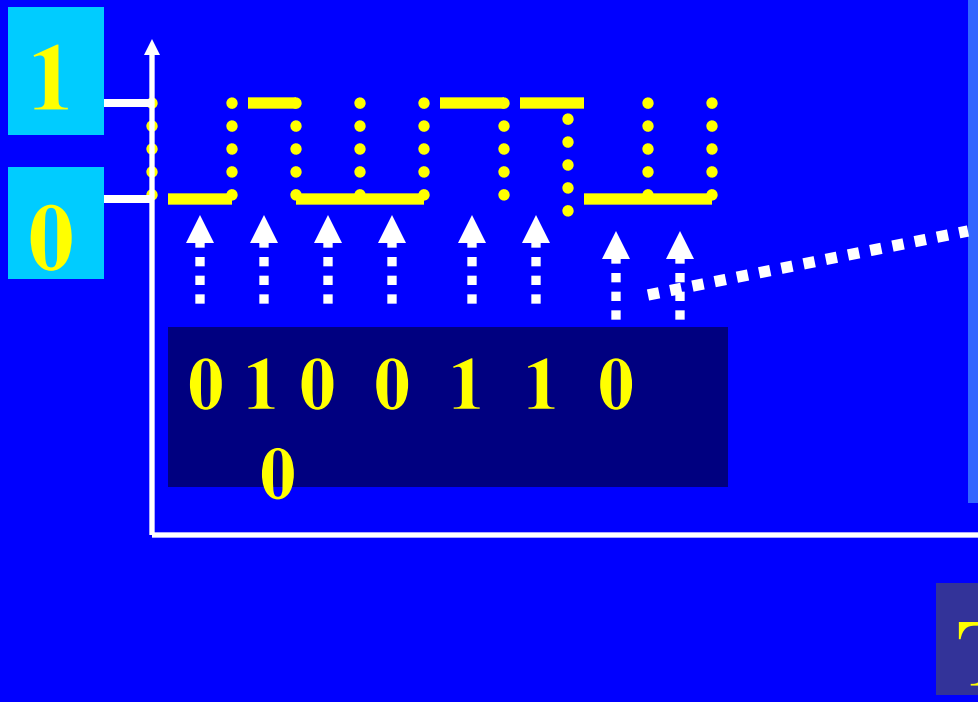


T = Interval between the bits set by transmitter clock

Advantages

- Only one line per channel suffices
- 0s and 1s can be appropriately modulated for long and remote distances communication and for high frequency transmission

Serial Receiver input 8 bits (01001100)



Receiver clock synchronization with transmitter clock

- 0s and 1s can be appropriately modulated with the clock signals for remote receiver to synchronize receiver clock with the transmitter clock, or
- A transmitter clock can also be explicitly sent separately along with a serial line for receiver to synchronize receiver clock with the transmitter clock, or

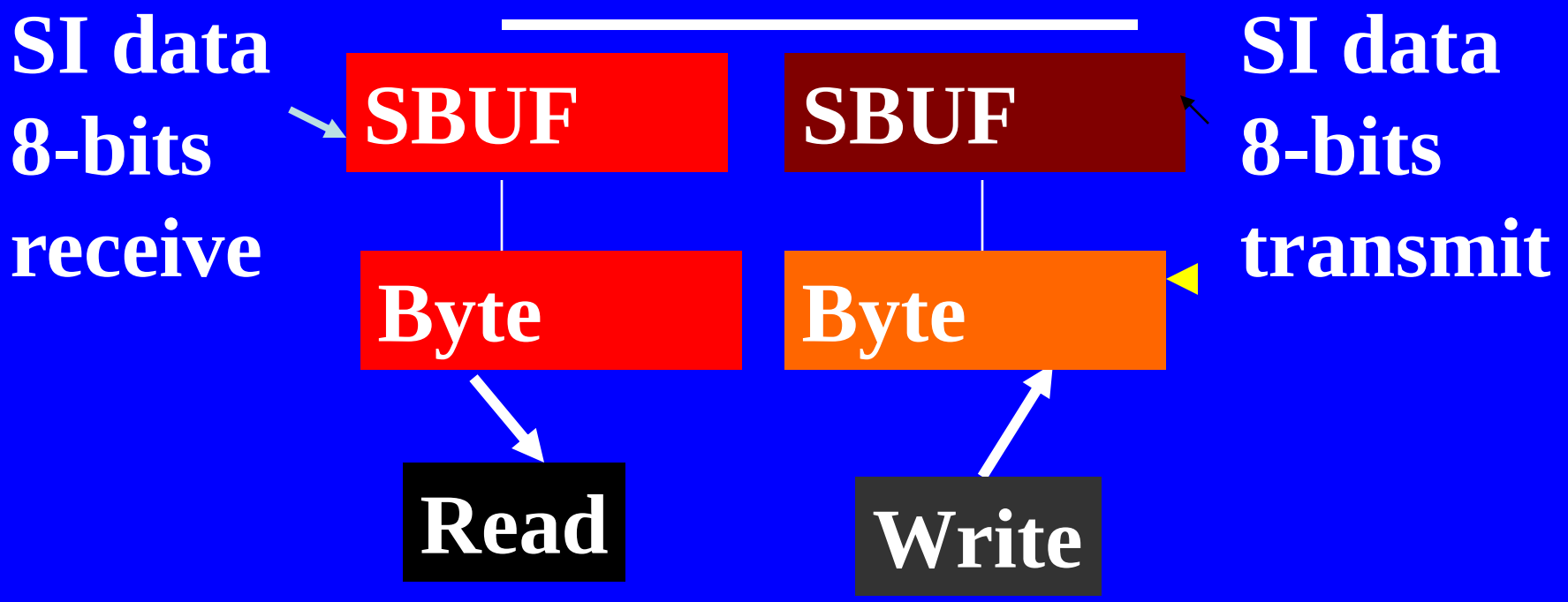
Receiver clock synchronization with transmitter clock

- The serial bits for a byte can precede the bits for a synch-code, and synch-code bits synchronize the receiving clock using the phases and intervals of these bits, or

Receiver clock rate adjustment with Transmitter Clock rate

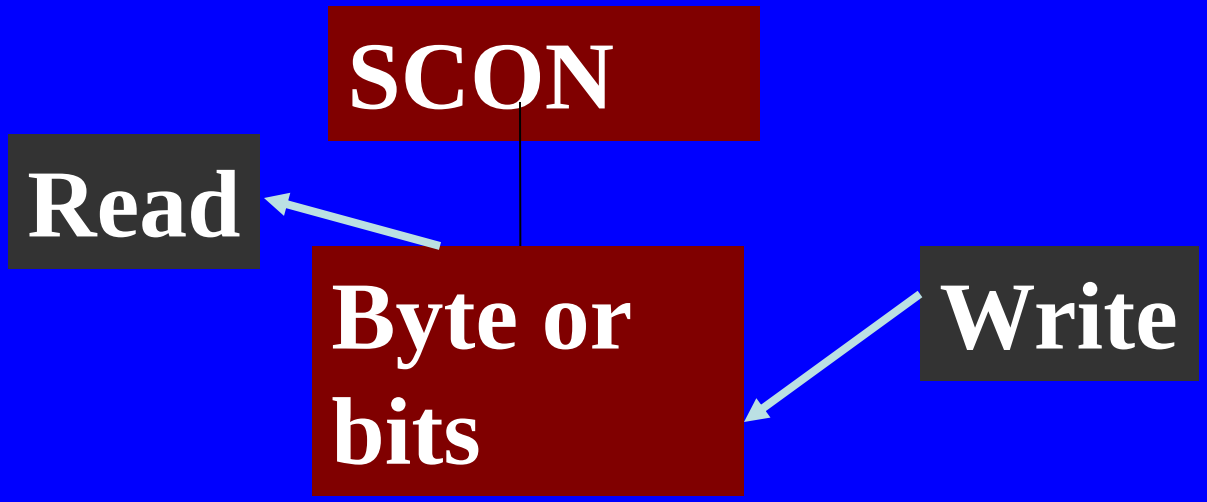
- The serial bits for a byte can precede a start bit and succeed a stop bit and receiver clock adjusts the interval T with the start bit-intervals

SI Device Data Read/Write Example



Serial Interface Device SI

Serial Interface Device SI



SI Device control Bits write or status read at register SCON

SI - Synchronous

Synchronous Mode Advantage

- **Fast transmission, usually at the system (MCU) clock rates.**

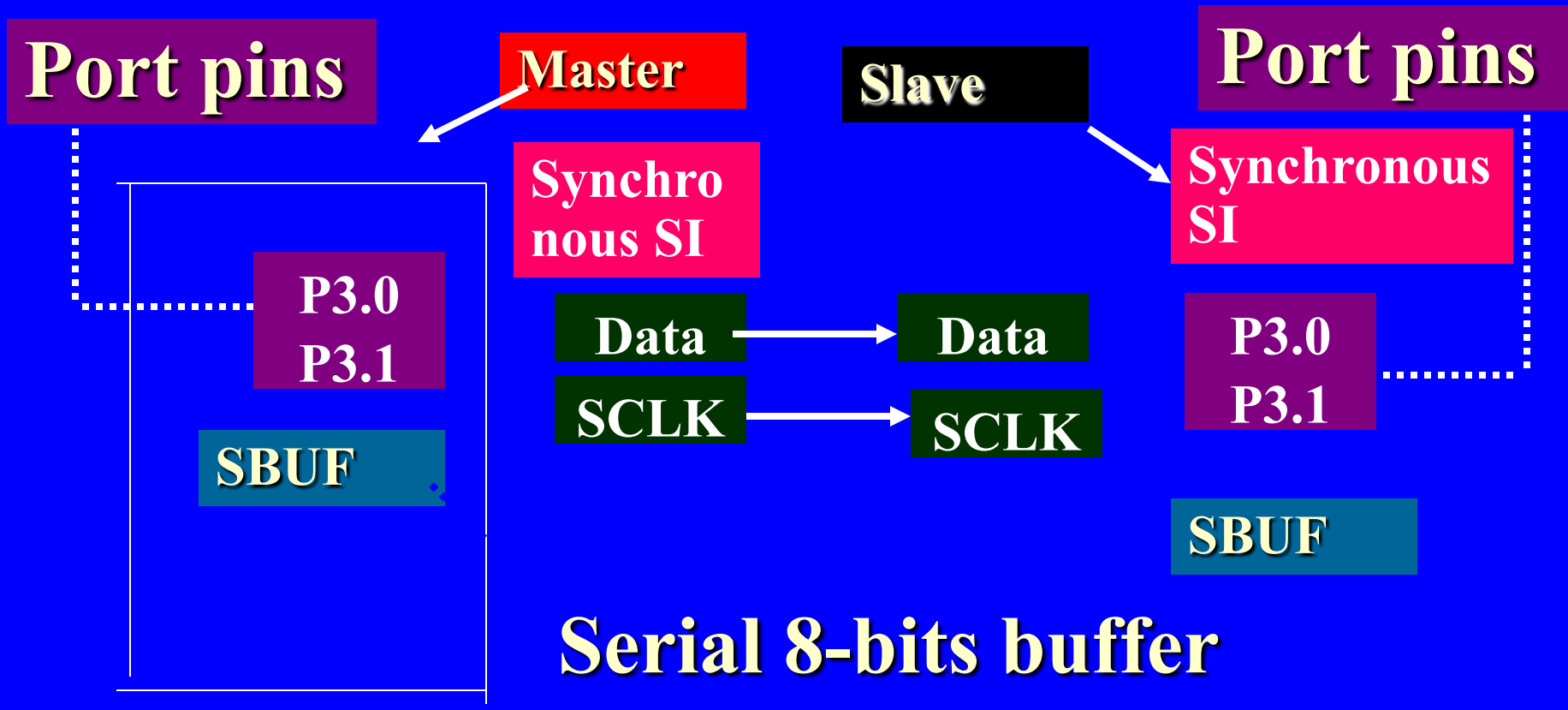
Synchronous Mode Advantage

- **Serial bit transmits at data pin and receives at slave data pin**
- **Synchronous SI Master device simultaneously transmits serial clock pulses so that slave can synchronize the clocking inputs with the serial data bits.**

Serial Interface SI Receiver Synchronization with transmitter clock

- A transmitter clock is explicitly sent separately along with a serial line for receiver to synchronize receiver clock with the transmitter clock,

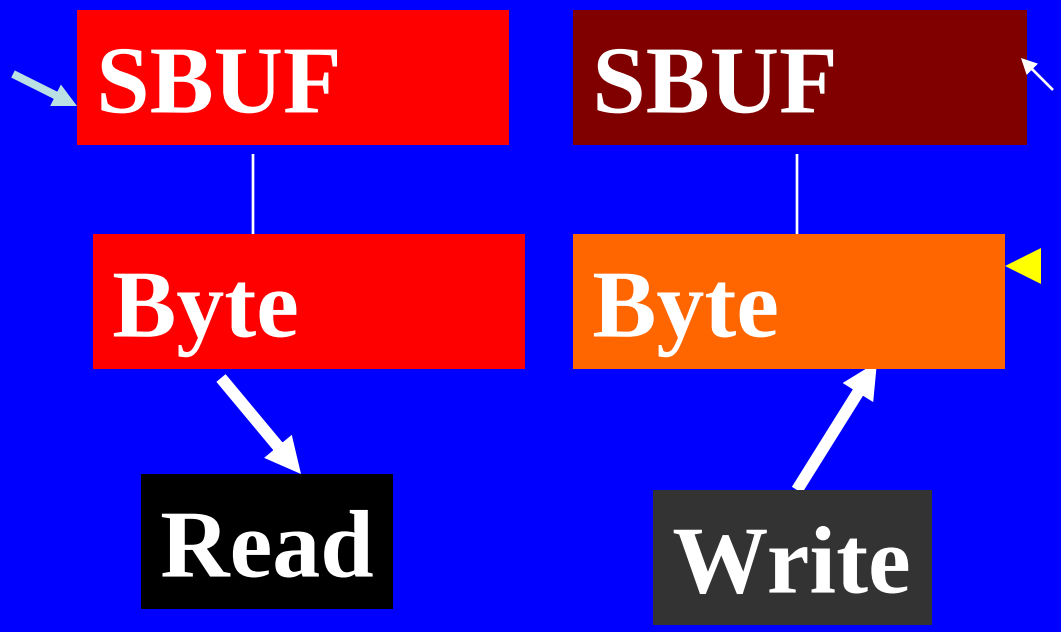
Synchronous SI Master- Slave Connection Between Two MCUs



Synchronous SI Device Data Read/Write Example

SI data 8-bits Receiv data in at P3.0

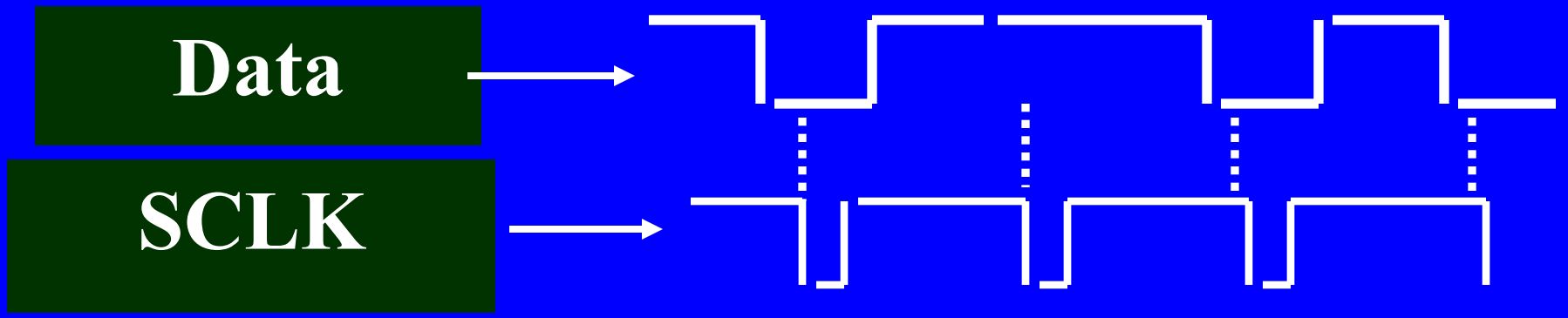
Clock in at P3.1



SI data 8-bits Transmit data out at P3.0

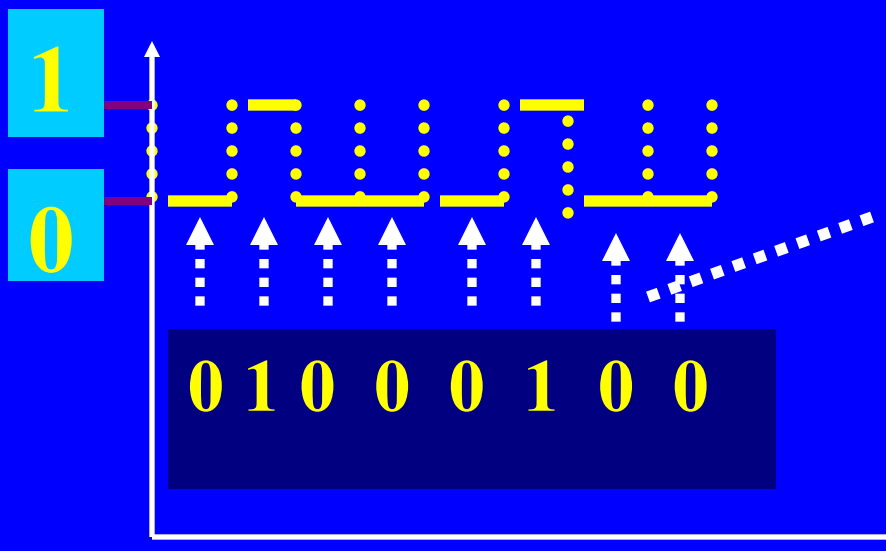
Clock out at P3.1

Synchronous SI Master output 4 bits (0100) and Clock pulses



lsb serial bit first out from SBUF

Serial Transmitter output 8 bits (01000100)



T = Interval between the bits set by transmitter clock

SI- UART mode

Serial bit SI UART mode transmits at TxD and reception at RxD pins

Receiver clock rate adjustment with Transmitter Clock rate

- The serial bits for a byte can precede a start bit and succeed a stop bit and receiver clock adjusts the interval T with the start bit-intervals
- T Interval = T, Serial Bits transmission rate = T^{-1} baud (baud per sec). Baud- A word for rain drops when drizzling

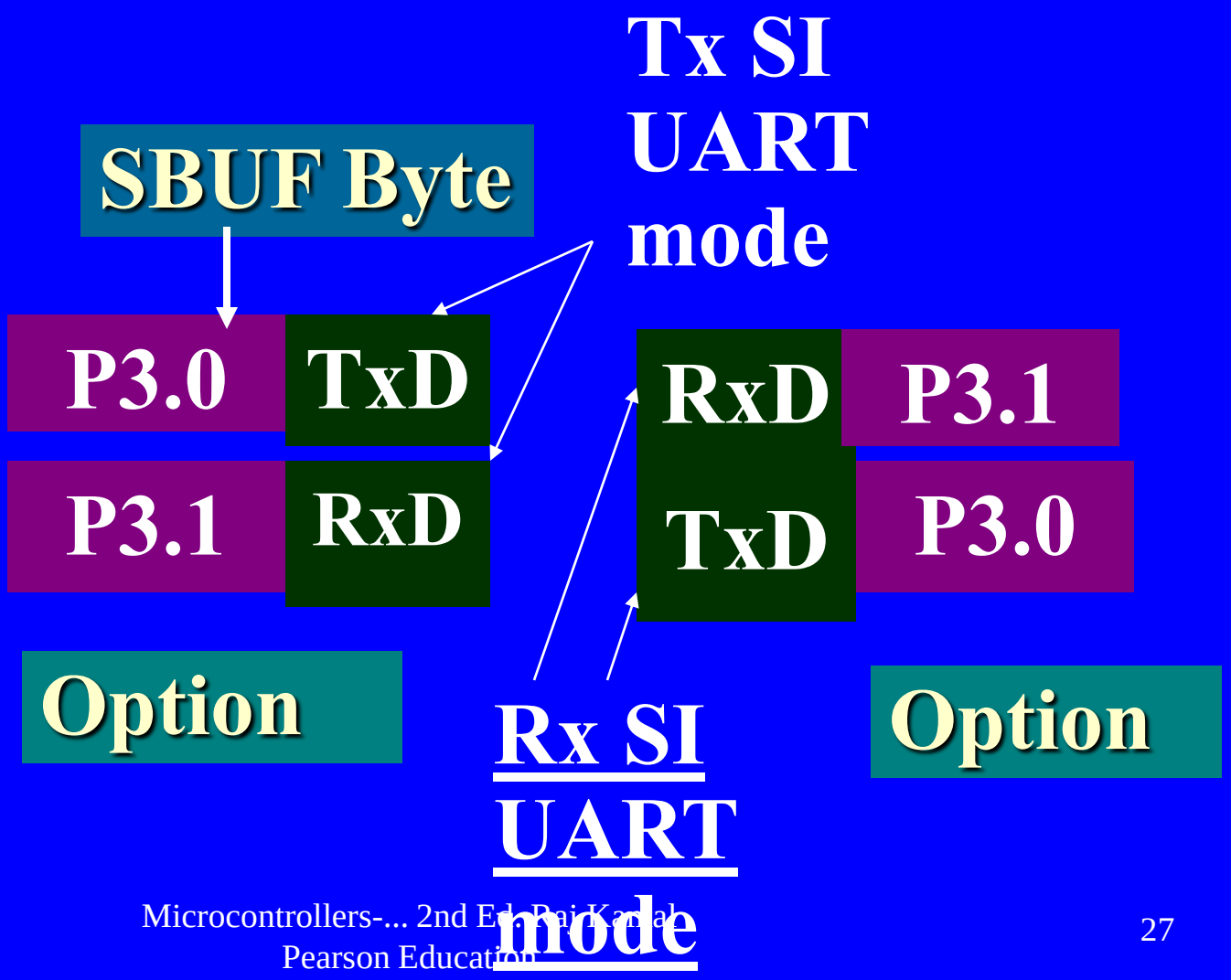
UART Mode Advantages

- Characters can sent with varying intervals between them
- Intermediate intervals between two characters or sets of characters used for handshaking messages between transmitter and receiver and interpreting the data bits

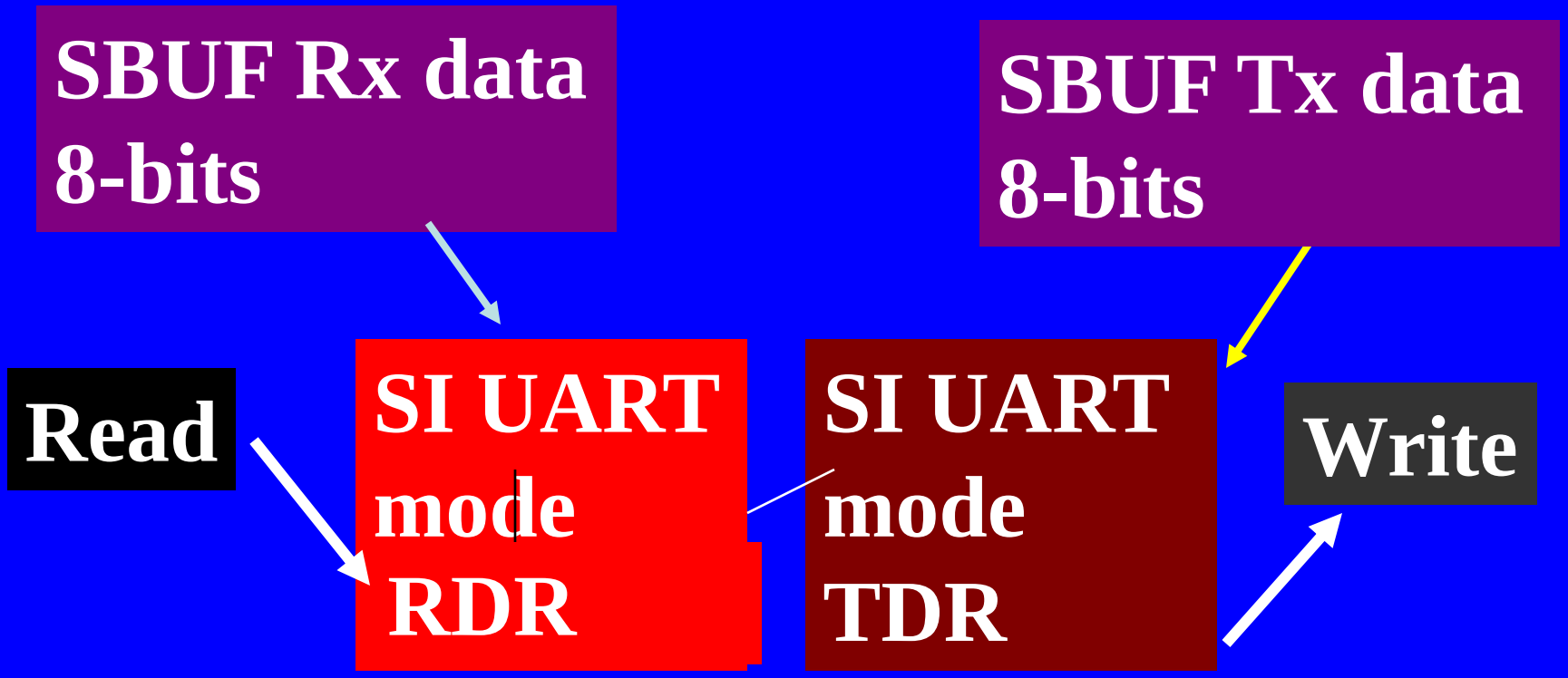
UART Mode Advantages

- ISR executed on receiving the byte can be longer as the intermediate intervals between stop bit and next start bit can be prolonged between two sets of characters

SI UART mode Tx Device and Rx Device - Between the MCUs



SI UART mode Device Tx-data and Rx-Data register bits



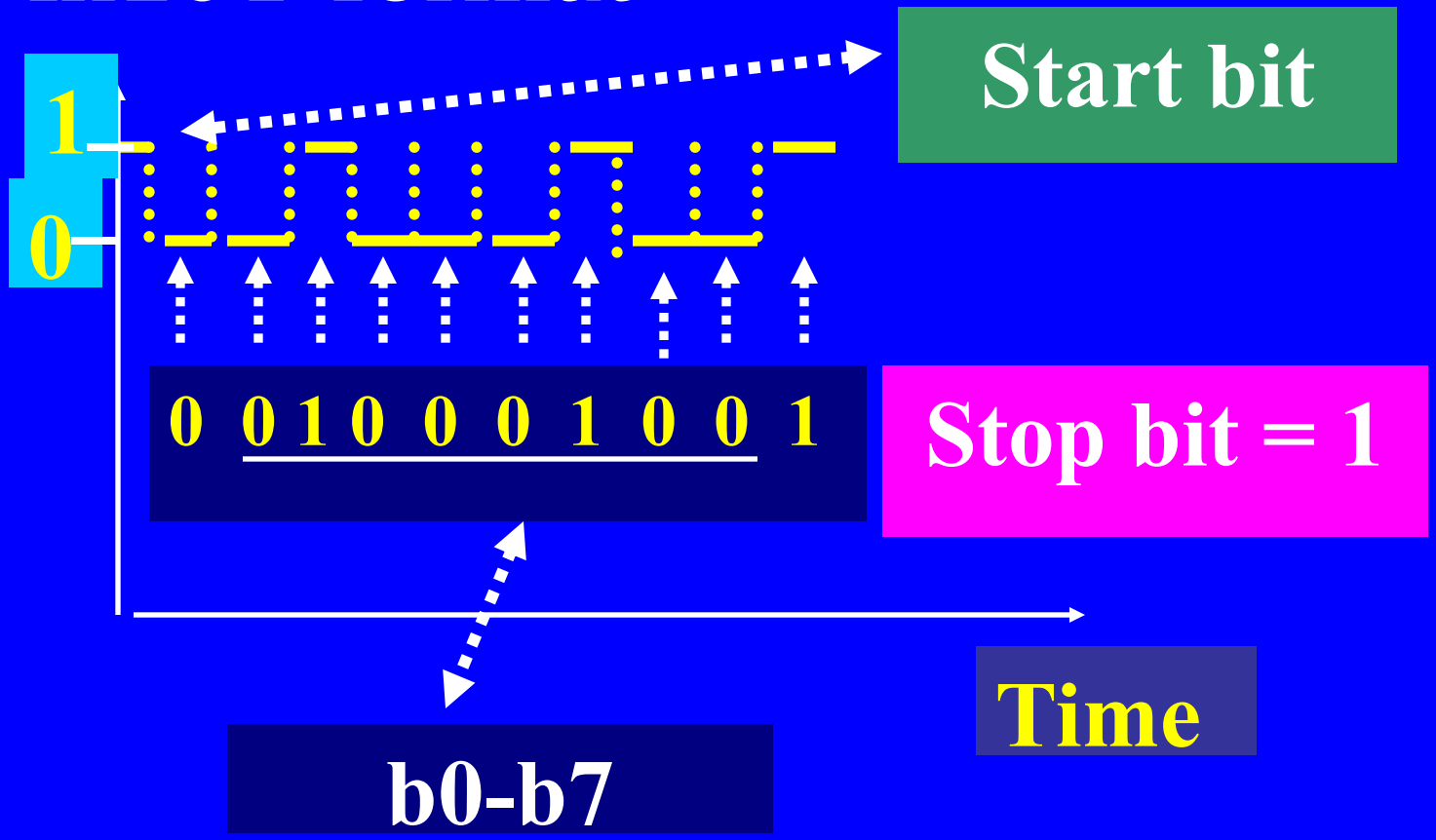
SI UART Two separate windows (double buffered) when Tx is taking place for SBUF output, input at RxD for SBUF input also occurs

SI UART mode Device Baud control

- SI UART mode Tx device does not simultaneously transmit serial clock pulses. Baud is however defined same at Tx SI UART mode and Rx SI UART mode.
- A timer may be baud rate generator.

SI- 10T mode without TB8 or RB8

UART SI output 8 bits (01000100) in10T format

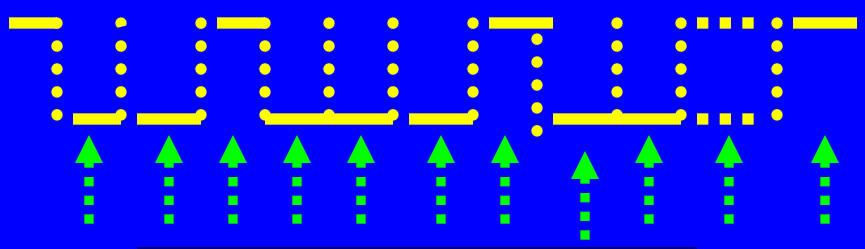


Outline

- Serial Communication
- SI - Synchronous
- SI- UART mode
- SI- 10T mode without TB8 or RB8
- **SI- 11T mode with TB8 or RB8**
- Receiver wake up feature in multiprocessor serial communications

UART SI output 8 bits (0100100) in11T format

Start bit



0 1 0 0 0 1 0 0

b0-b7

Stop bit = 1

TB8 = 0 or 1 as per 8th bit to be sent by transmitter

Advantages of sending TB8 and receiving RB8

- TB8 can be used to send the parity (a bit after counting the number of 1s in the character). RB8 received 8th bit after b0-b7 bits for data will then let then receiver check for parity error.

Advantages of sending TB8 and receiving RB8

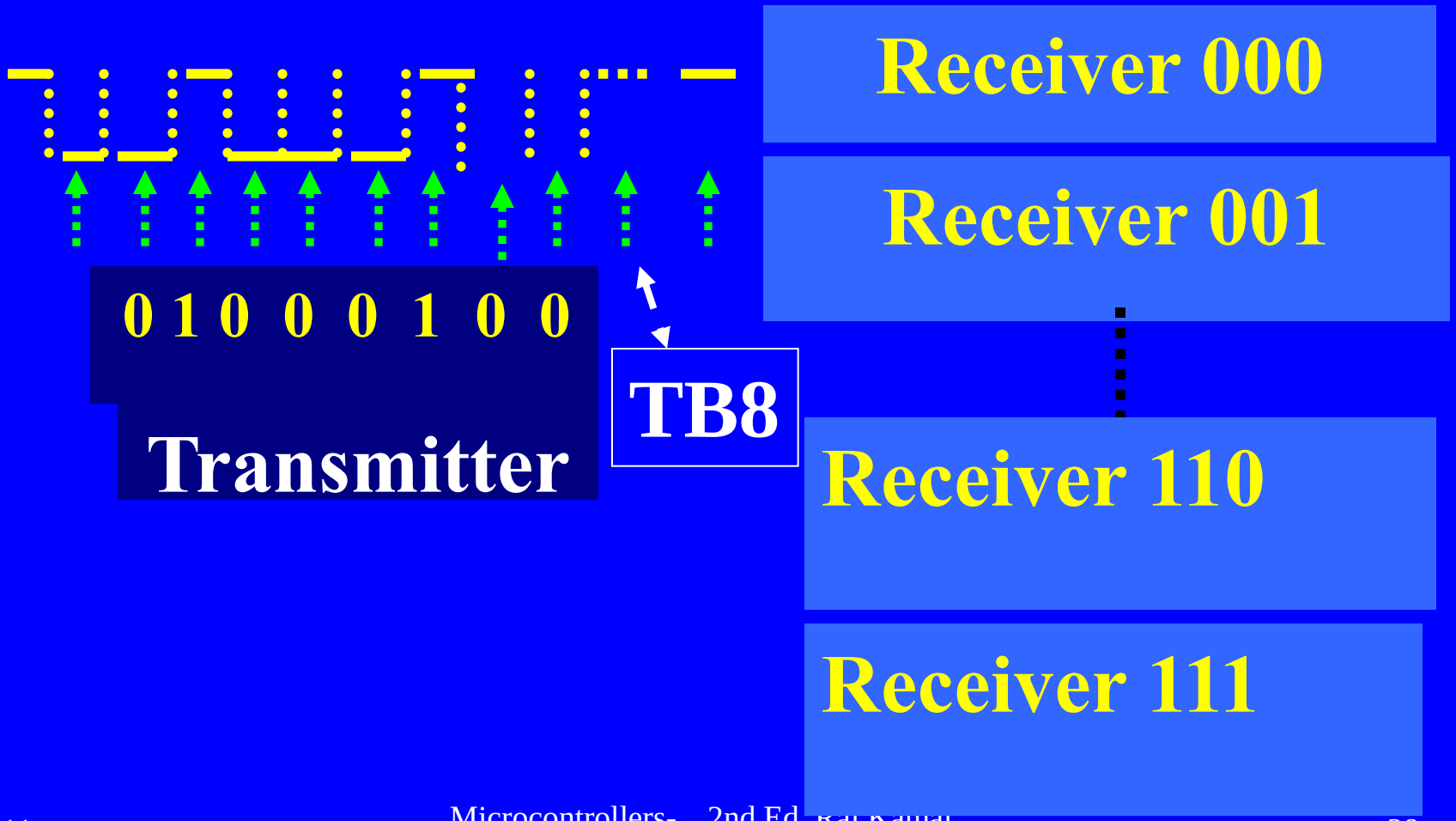
- TB8 can be used to send through b0-b7 the address of the receiver when TB8 set to 1 and data bits through b0-b7 when reset to 0 so that only select addressed receiver among several ones identify the data bits

Advantages of sending TB8 and receiving RB8

- TB8 can be used to send the command through b0-b7 to the receiver when TB8 set to 1 and data bits through b0-b7 when reset to 0 so that receiver interprets the data as per the previous command.

Receiver wake up feature in multiprocessor serial communications

Eight Multiprocessor Systems connected to a Serial Transmitter



Multi-processors communication in UART SI uses a wake up bit RWAK (SM2 in 8051) at Serial control register

- TB8 is used to send through b0-b7 the address of the receiver when TB8 set to 1 and data bits through b0-b7 when reset to 0 so that only select addressed receiver among several ones identify the data bits sent at the succeeding characters

Serial Communication UART Control RWAK bit

- When RWAK= 1 then a receiver interrupt (RI) occurs when RB8 = 1 and RI does not activate when RB8 bit is received 0.

Serial Communication UART Control RWAK (SM2) bit application 11T mode in multiprocessor communication

- **First each receiver RWAK bit is set to 1. Each receiver activates receiver interrupt when RB8 = 1,therefore reads the 8-bits and check- *does it corresponds to its predefined address (000 or 001 or ..?***

Then each receiver RWAK bit is kept to 1 *except the one*, which successfully checked its address . That receiver RWAK bit is forced = 0, it therefore keeps on activating RI each time whether RB8 = 0 or 1,therefore it reads the 8-bits and receives the data. Whenever it finds RB8 = 1, it again checks its address, if not found same as before, it forces RWAK again = 1.

Summary

We learnt
Serial Transmission

- A stream of 1s and 0s is sent
- Interval = T, Serial Bits transmission rate = T^{-1} bps (bit per sec).
- UART Interval of serial bits = T, Serial Bits transmission rate = T^{-1} baud (baud per sec)

We learnt Serial Transmission

- Synchronous SI—Separate clock line
- SI UART mode— Two Modes - not using and using TB8 (10T or 11T)
- Use of RWAK bit (SM2 bit) for multi processor UART mode communication