

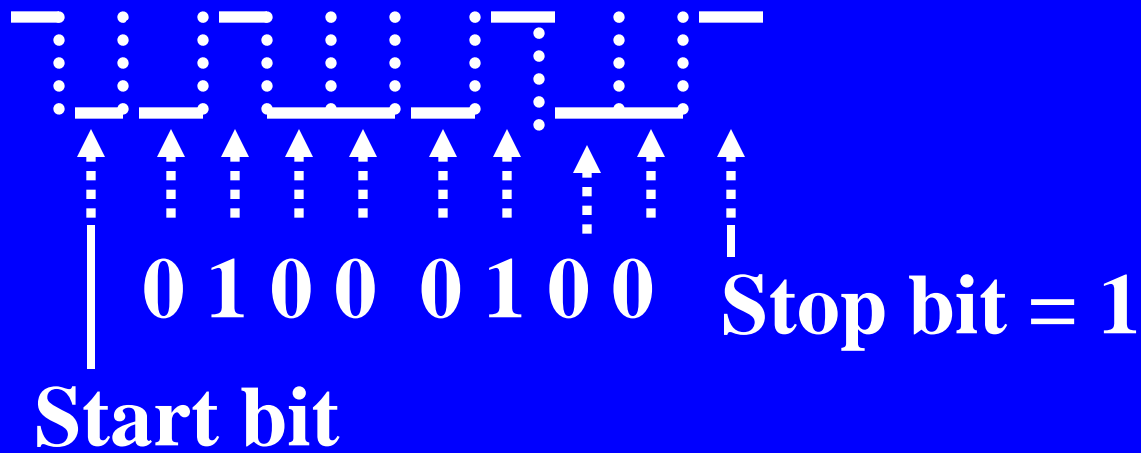
# Chapter 7

## System Design: Peripheral ICs and Interfacing

# Lesson 1

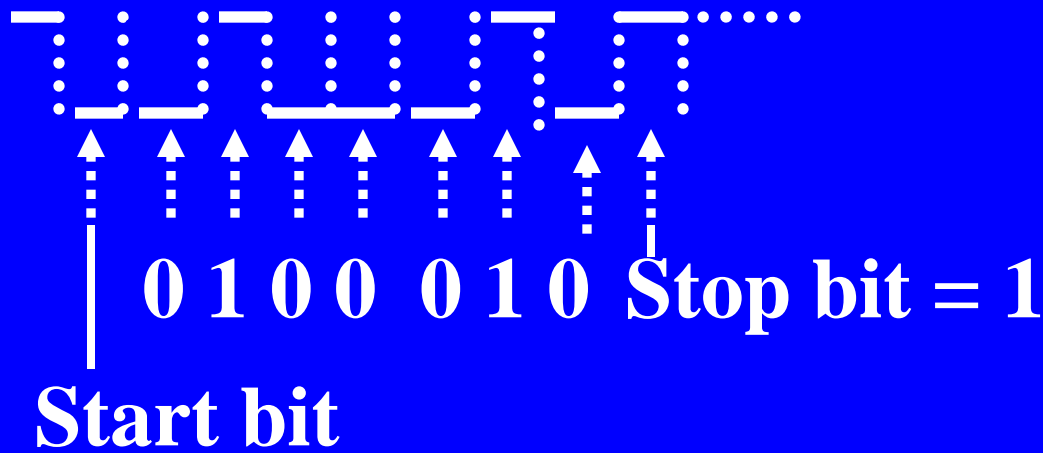
## **8251- USART (Universal Synchronous Asynchronous Receiver and Transmitter)**

UART output 8 bits (01000100) in 10T format



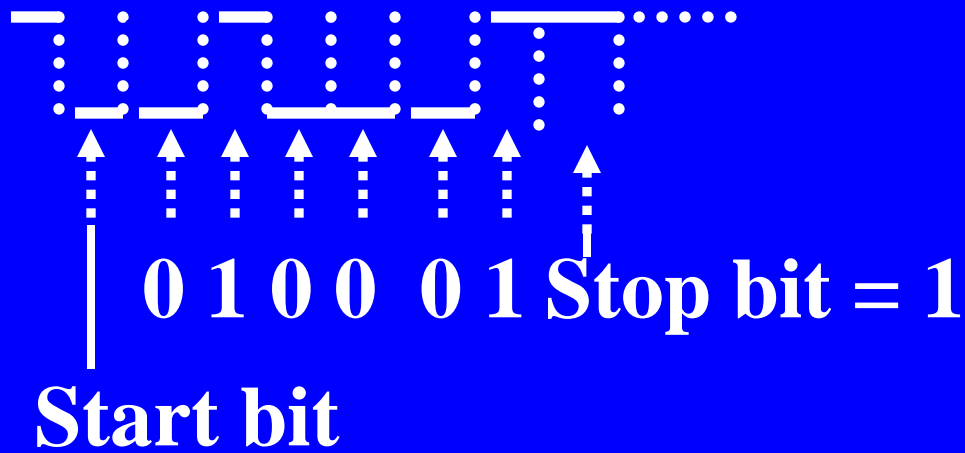
Asynchronous serial communication with one start bit (0) and one stop bit (1)

# UART output 7 bits (0100010) in 9T format



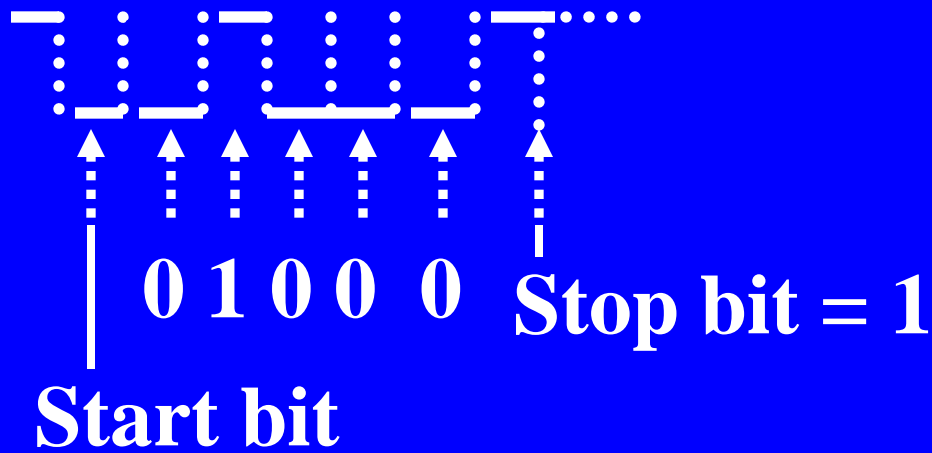
Asynchronous serial communication with one start bit (0) and one stop bit (1)

# UART output 6 bits (010001) in 8T format



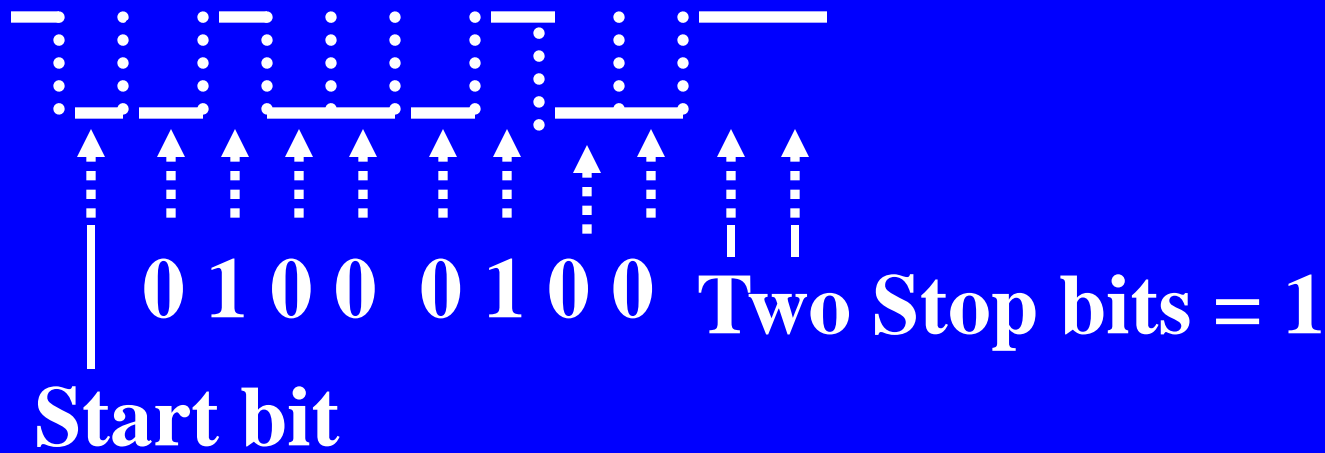
Asynchronous serial communication with one start bit (0) and one stop bit (1)

# UART output 5 bits (01000) in 7T format



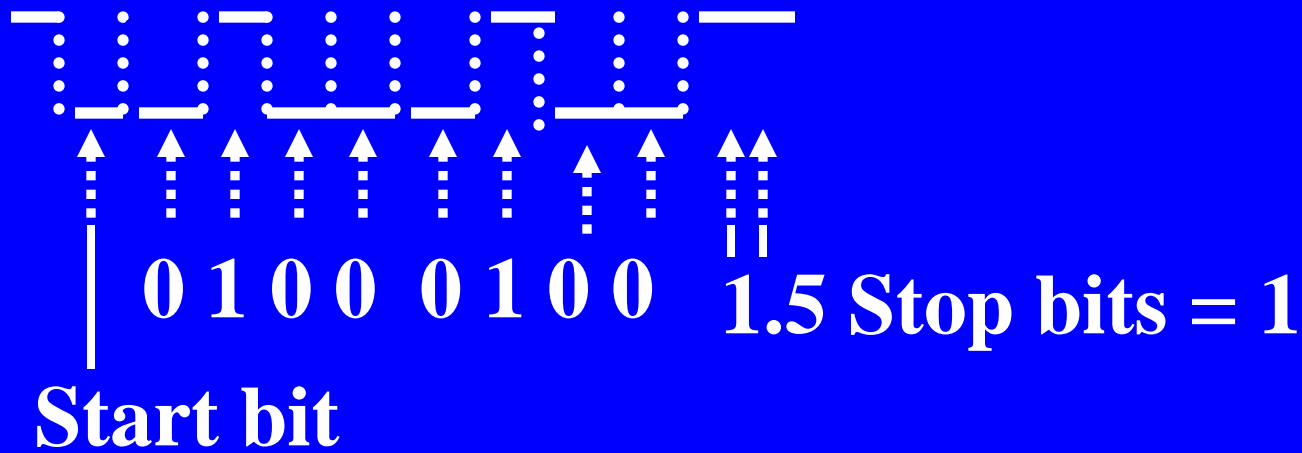
Asynchronous serial communication with one start bit (0) and one stop bit (1)

UART output 8 bits (01000100) in 11T format



Asynchronous serial communication with one start bit (0) and two stop bits (11)

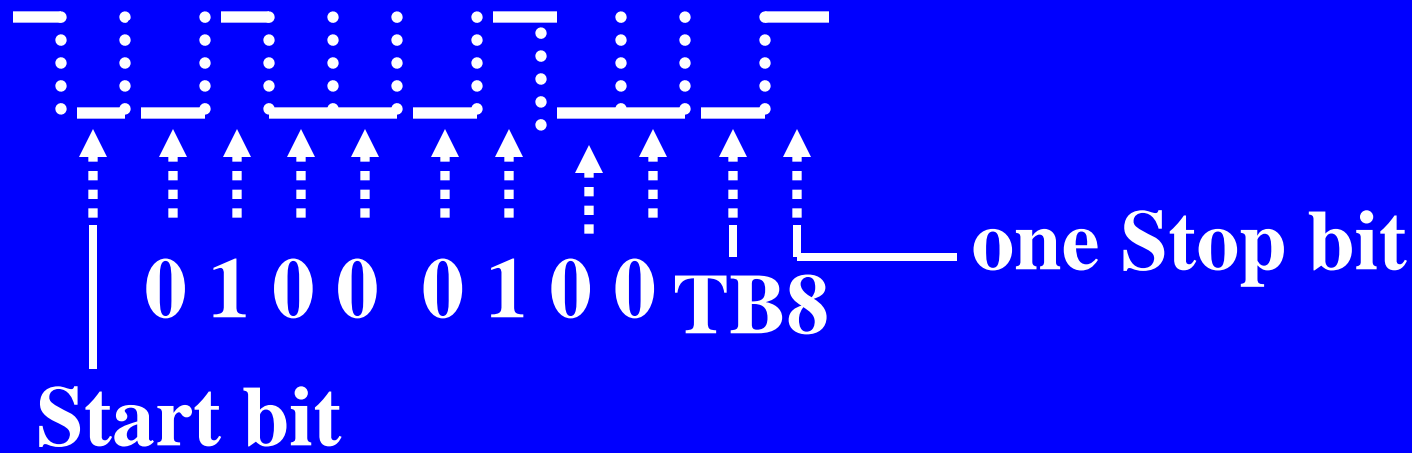
# UART output 8 bits (01000100) in 10.5 T format



Asynchronous serial communication with one start bit (0) and 1.5 stop bits (1)

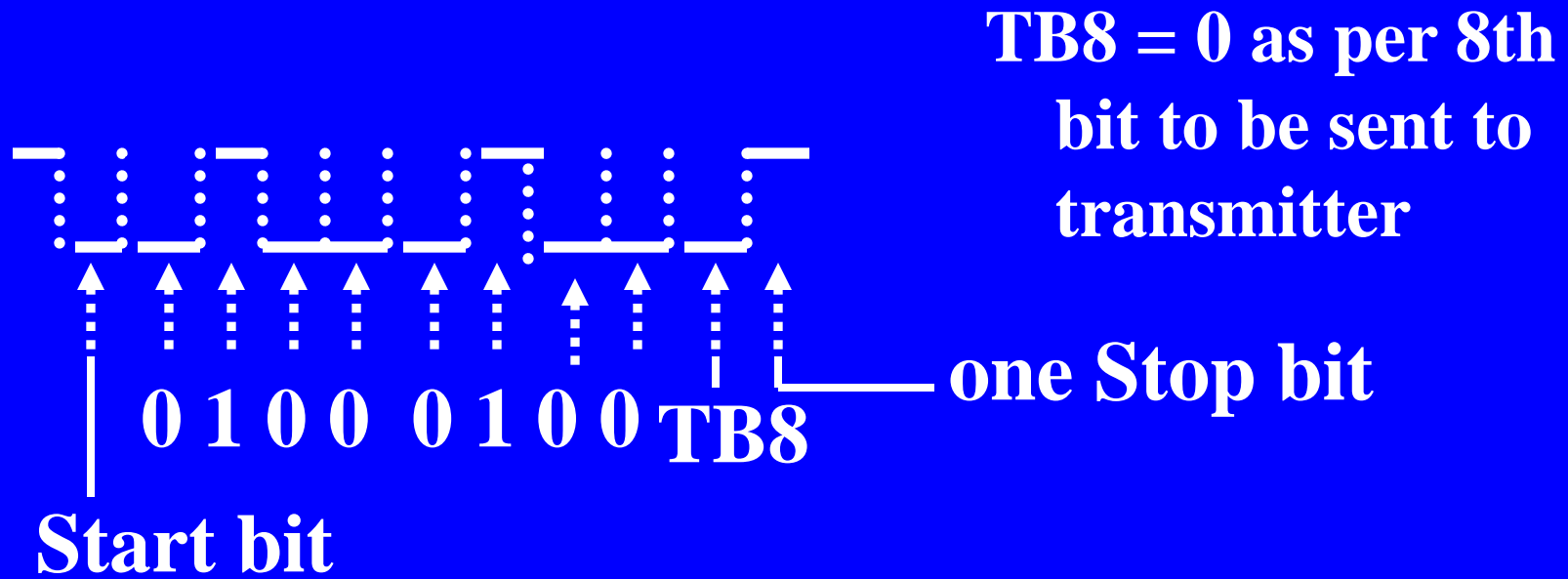


UART output 8 bits (01000100) in 11T format with assuming TB8 = 0



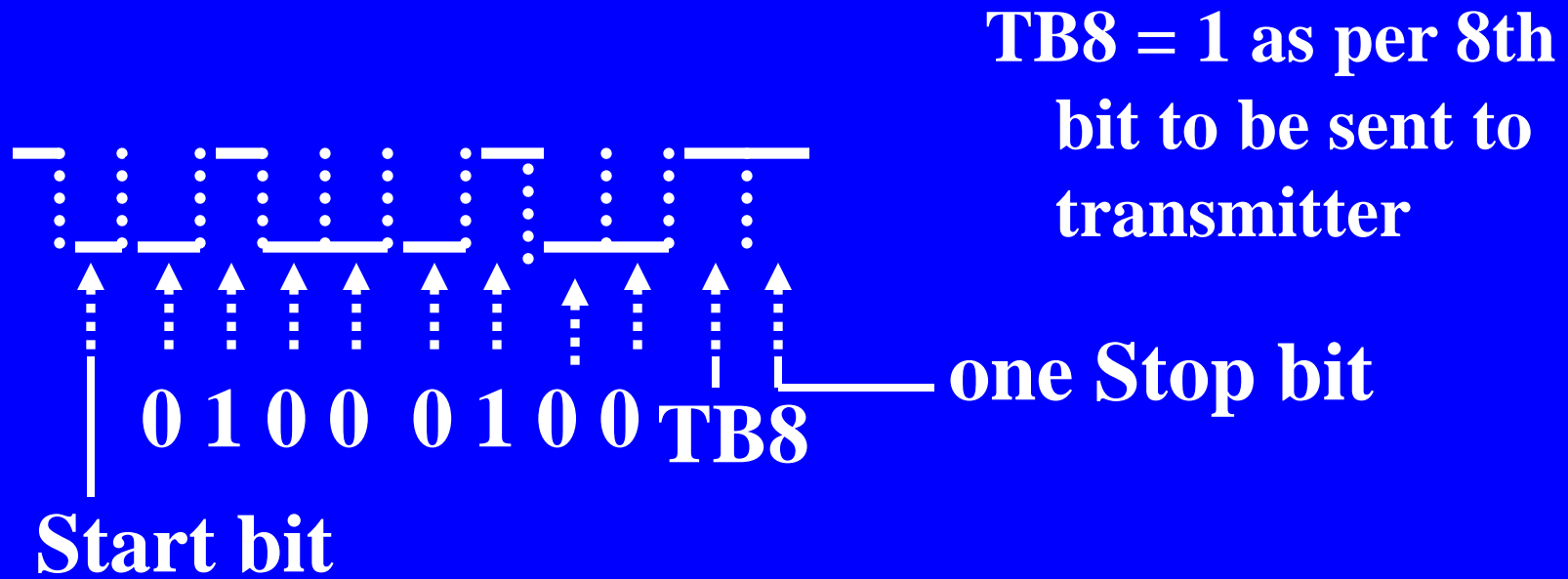
Asynchronous serial communication with one start bit (0), one TB8 (0) and two stop bits (11)

UART output 8 bits (01000100) in 11T format with assuming TB8 = 0



Asynchronous serial communication with one start bit (0), one TB8 (0) and two stop bits (11)

UART output 8 bits (01000100) in 11T format with assuming TB8 = 1



Asynchronous serial communication with one start bit (0), one TB8 (1) and two stop bits (11)

# TB8 in case of UART output 8 bits (01000100) in 11T format

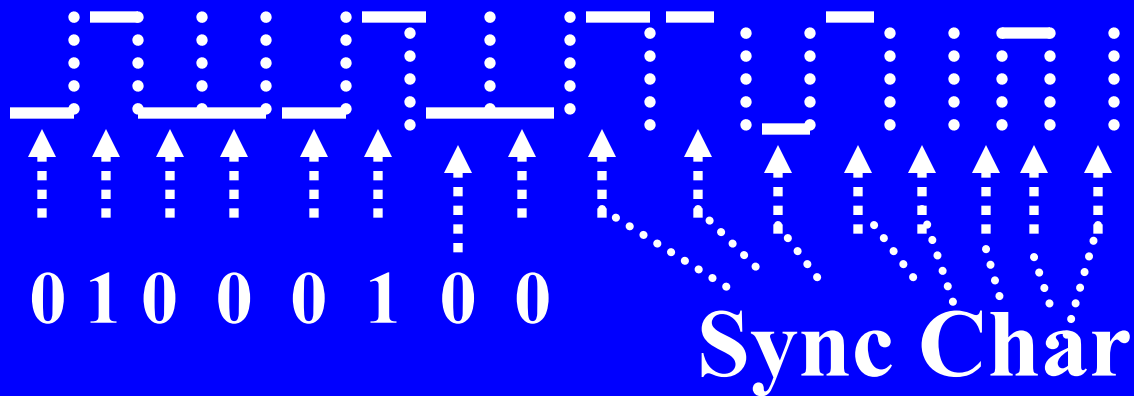
- TB8 a programmed bit as always 0
- TB8 a programmed bit as always 1
- TB8 a programmed bit as a parity odd bit
- TB8 a programmed bit as a parity even bit

# **TB8 in case of UART output 8 bits (01000100) in 11T format**

- TB8 a programmed bit for interpreting it as command indication from 8 sent bits
- TB8 a programmed bit for interpreting it as address indication from 8 sent bits
- TB8 a programmed bit for interpreting it as data indication from 8 sent bits

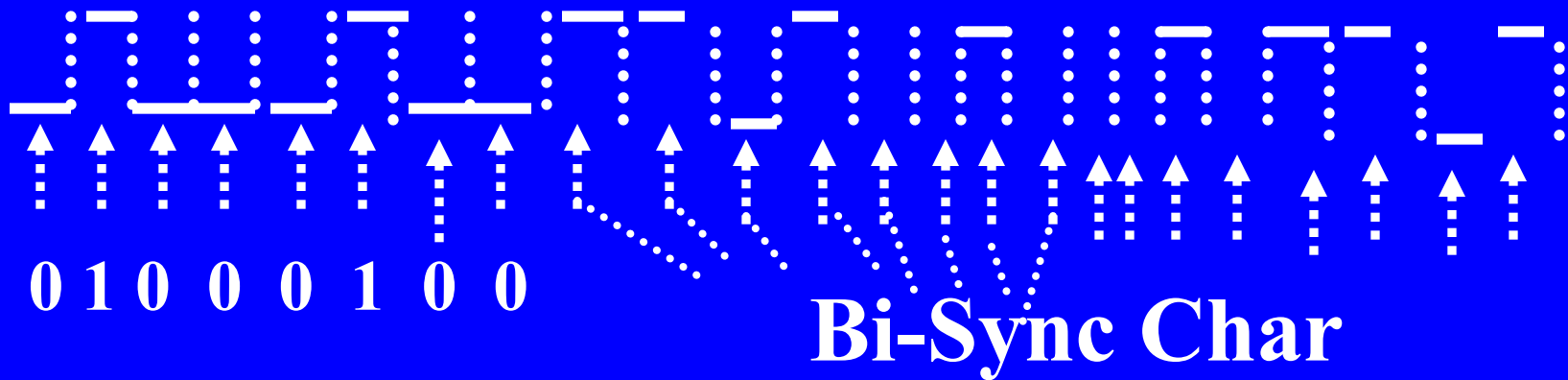
# 8251 in synchronous Mode

# Sync mode output 8 bits (01000100) in 16T format



Synchronous serial communication

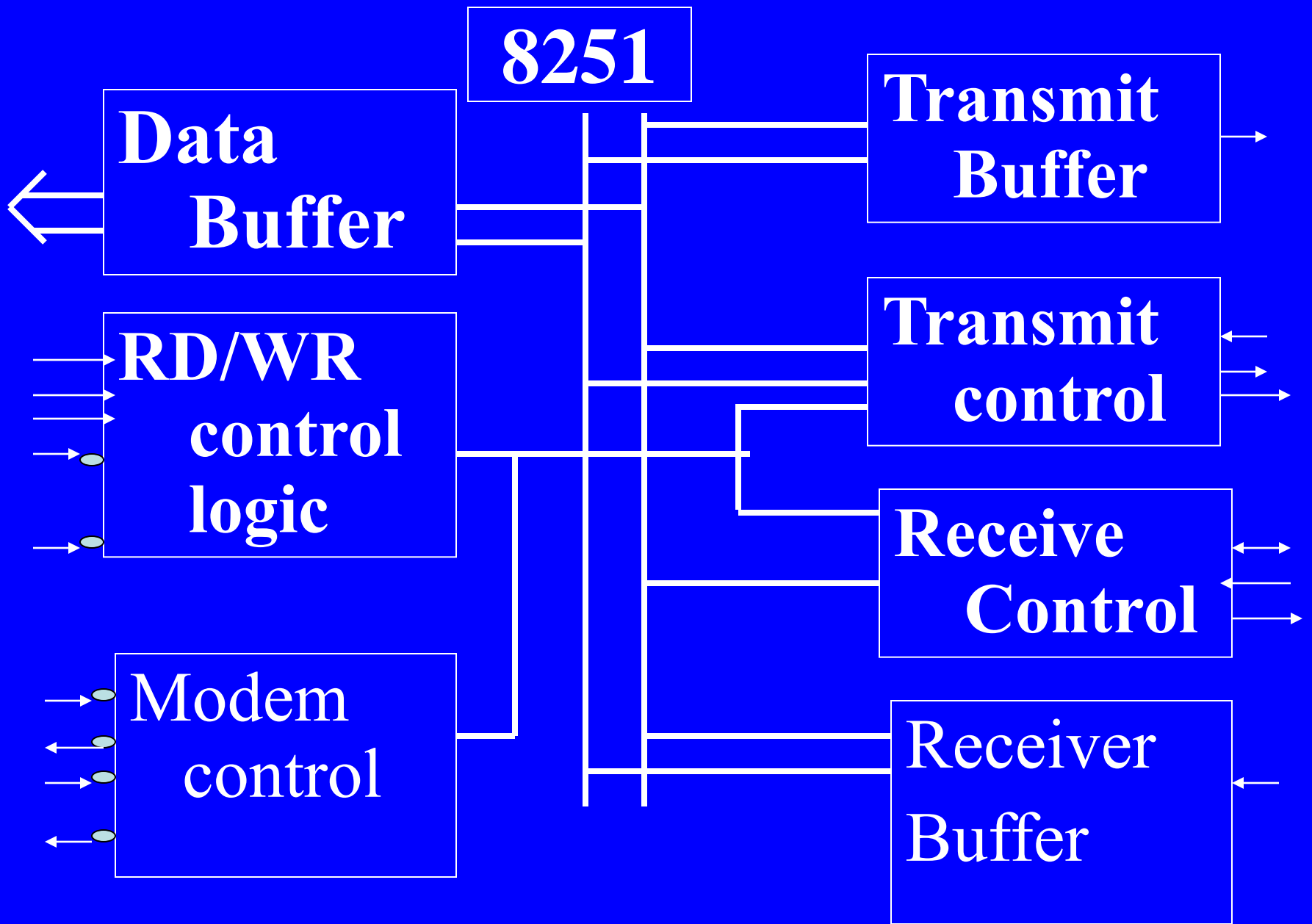
# Sync mode output 8 bits (01000100) in 24T format

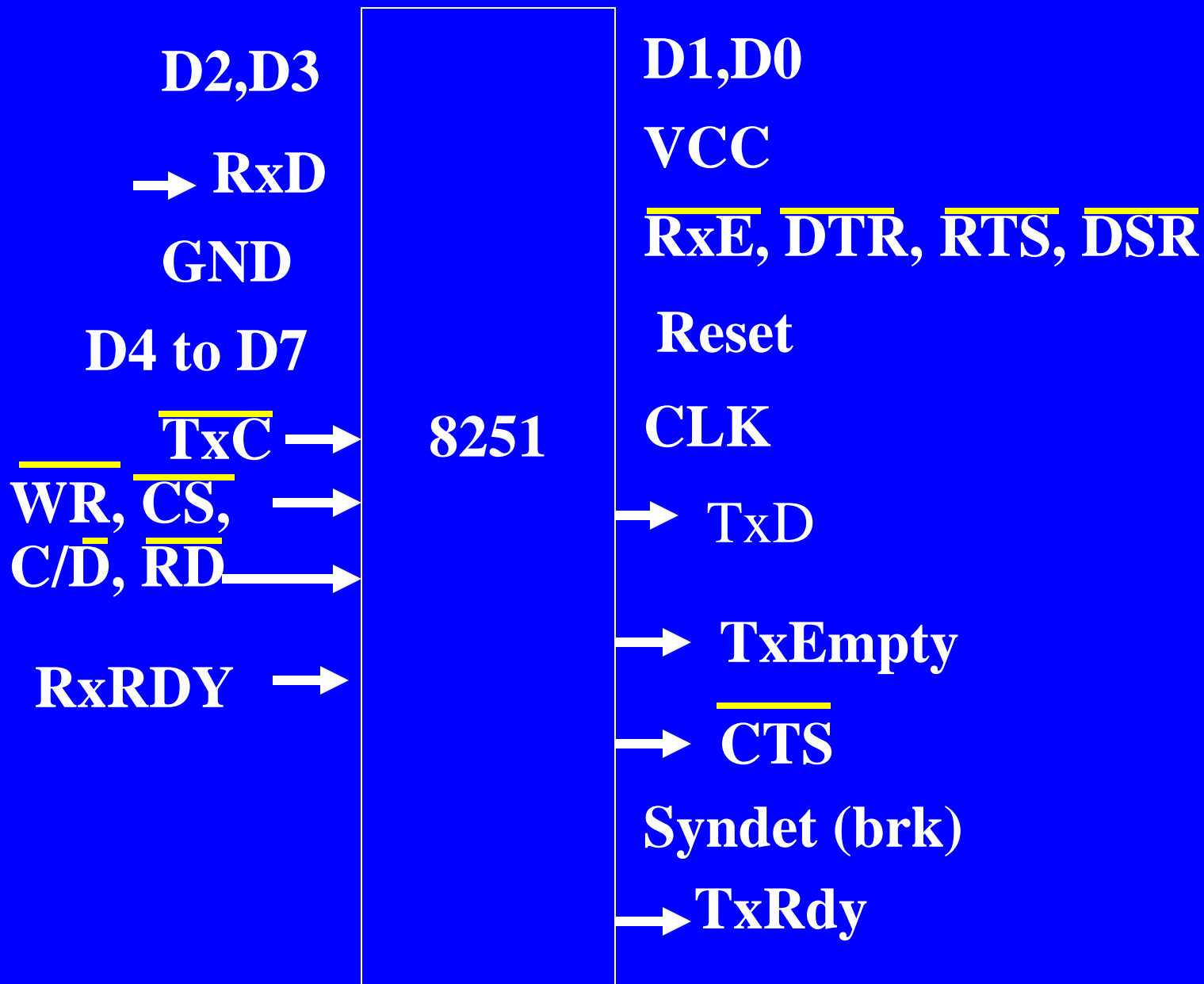


Synchronous serial communication



# 8251 Block diagram and Pins



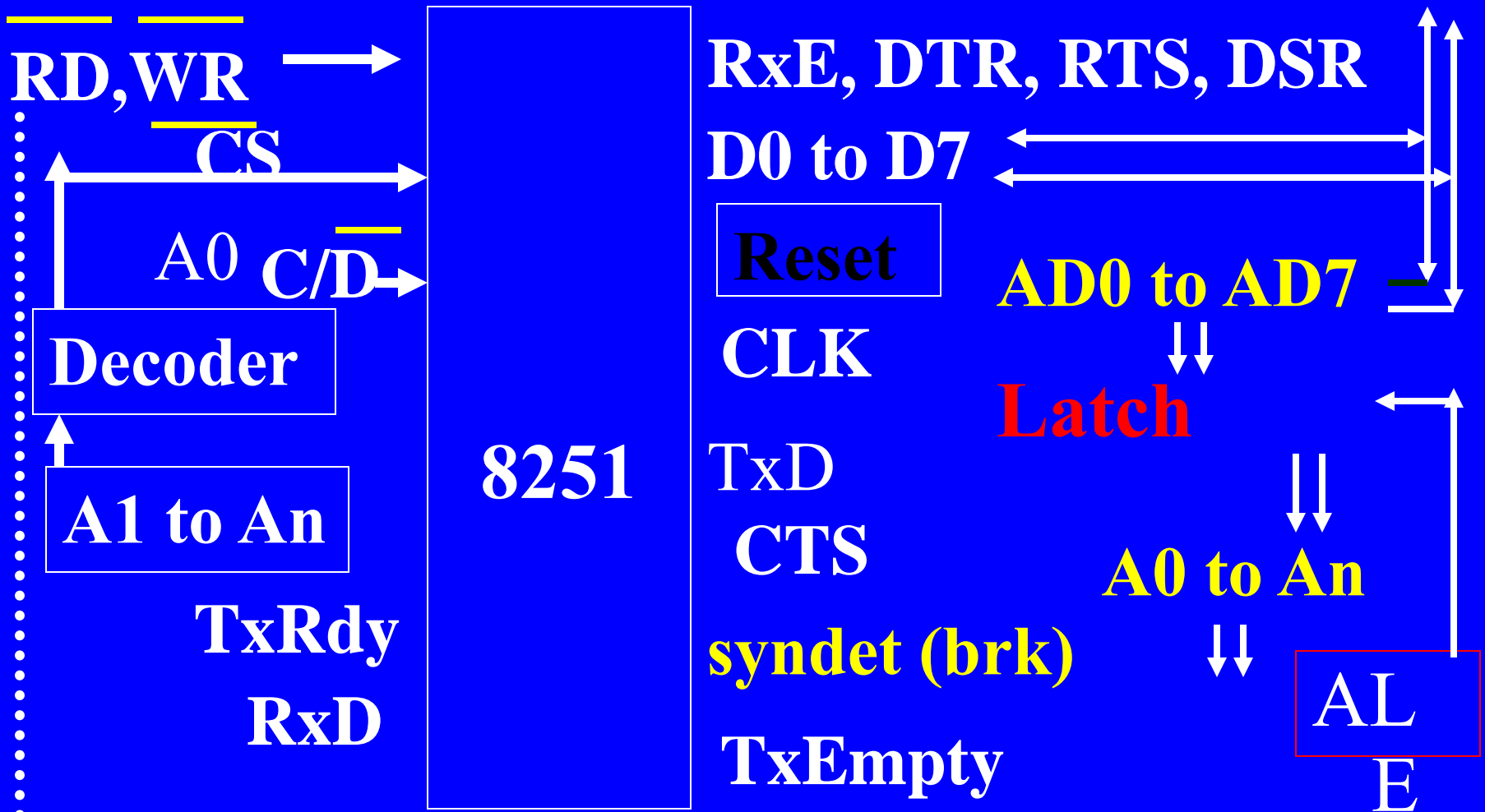


# Table 7.1- Block Functions

# Table 7.2- Each Pin signals

# 8251 Interfacing

# Table 7.3- Port Addresses for a typical interface circuit of figure 7.3



(**WR, IOWR** or P3.7) and (**RD, IORD** or P3.6)  
 or **R/W** and **NOT(R/W)**

# 8251 Programming



# Programming the 8251 Mode and sending commands to 8251

When  $\overline{CS} = 0$ ,  $C/\overline{D} = 1$ , and  $\overline{WR} = 0$  then 8251 gets Mode/Command bytes

# Sequential order of Bytes after reset

## Mode Instruction

If sych mode- sync character

If bi-sync mode- second sync character

## Command Instruction

Mode Instruction if bit b6(IR) internal reset bit is set else command instruction

# Mode Instruction

- b0 and b1 both not 0s UART mode
- b0 and b1 both 0s the *sync* or *bi-sync* mode

## UART mode instruction (b0 or b1= 1)

1. b1-b0 = 01 means clock 1 X undivided

b1-b0 = 10 means clock 16 X divides by 16

b1-b0 = 11 means clock 64 X divides by 64

2. b3-b2= 00 means 5-bit / character

b3-b2= 01 means 6-bit / character

b3-b2= 10 means 7-bit / character

b3-b2= 11 means 8-bit / character

## UART mode instruction (b0 or b1= 1)

1.  $b_4 = 1$  parity enable (odd or even as per  $b_5$ ), else none parity
2.  $b_5-b_4 = 01$  means odd parity=  $11$  means even parity
3.  $b_7-b_6 = 00$  invalid code  
 $b_7-b_6 = 01$  means 1 stop bit  
 $b_7-b_6 = 10$  means 1.5 stop bit  
 $b_7-b_6 = 11$  means 2 stop bit

# USRT sync mode instruction (b0 and b1= 0)

1.  $b_3-b_2=00$  means 5-bit / character

$b_3-b_2=01$  means 6-bit / character

$b_3-b_2=10$  means 7-bit / character

$b_3-b_2=11$  means 8-bit / character

## USRT sync mode instruction (b0 and b1= 0)

1. b4 = 1 parity enable (odd or even as per b5), else none parity
2. b5-b4= 01 means odd parity= 11 means even parity
3. b6 (ESD) = 1 External Sync detect (means Syndet pin is input)  
  
b6 (ESD) = 0 External Sync not detect internal sync detect (means Syndet pin is output)

# USRT sync mode instruction (b0 and b1= 0)

4. b7 (SCS) = 1 bi-sync mode

b7 (SCS) = 0 single sync mode



# Command Instruction

- Second byte, b0 and b1 at mode both not 0s  
UART mode
- Third or fourth bytes, b0 and b1 both 0s the *sync*  
or *bi-sync* mode

## Command instruction

1.  $b_0 = 1$  means enable, 0 disable transmitter
2.  $b_1 = 1$  means data terminal ready, activate DTR pin
3.  $b_2 = 1$  means enable, 0 disable receiver
4.  $b_3 = 0$  means normal case, 1 Send break character, make  $TxD = 0$
5.  $b_4$  (ER) = 1 means error reset, 0 no ER  
reset FE, OE and PE bits at status register

# Command instruction

6. b5 = 1 means *request to send*, activate RTS pin

7. b6 (IR)= 1 means internal reset so that next byte is taken as mode instruction

8. b7 (EH)= 1 means enter hunt mode, search for sync char or bi-sync char, 0 no EH. EH has no meaning in UART mode

Command bits

command bits

EH	RTS	ER	IR	REN	TxEN	DTR	RTS
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# Status Byte

When  $\overline{CS} = 0$ ,  $C/\overline{D} = 1$ , and  $\overline{RD} = 0$  then 8051 reads status byte

## Status flags

b0 Tx-RDY

b1 Rx-RDY

b2 RxRDY

and byte received is in  
buffer

b6 Syndet/brk

b7 DSR data set ready

## Status error flags

b3 PE3 Parity error

b4 OE Over run error

b5 FE Frame error

Examples 7.1 and 7.2 - show  
programming examples

Figure 7.5(a) - Syndet to external  
character sending device

Figure 7.5(b) - Syndet to external  
modem device

# Summary



# 8251 Programmability

We learnt

8251 Features

1. Serial Communication Receiver cum transmitter
2. Serial asynchronous receiver and transmitter with a start bit and 1, 1.5 or 2 stop bits
3. Serial synchronous - single sync or double sync

We learnt

4.Full duplex programmable rate communication, settable for 5-, 6-, 7- or 8-bit per char

5.Serial Communication Receiver cum transmitter control for modem DCE

# We learnt

## Mode/Commands

- Mode instruction after internal or external reset
- Command instruction after mode or after mode + sync characters