

3.2 PARALLEL COMMUNICATION INTERFACE

8255 (PROGRAMMABLE PERIPHERAL INTERFACE)

The 8255 is a widely used, programmable parallel I/O device. It can be programmed to transfer data under various conditions, from simple I/O to interrupt I/O. It is an important general purpose I/O device that can be used with almost any microprocessor.

The 8255 has 24 I/O pins that can be grouped primarily into two 8 bit parallel ports: A and B, with the remaining 8 bits as Port C. The 8 bits of port C can be used as individual bits or be grouped into two 4 bit ports: Copper (CU) and Cower (CL). The functions of these ports are defined by writing a control word in the control register.

8255 can be used in two modes: Bit set/Reset (BSR) mode and I/O mode.

- The BSR mode is used to set or reset the bits in port C.
- The I/O mode is further divided into 3 modes:
 - **mode 0**- all ports function as simple I/O ports
 - **mode 1** - a handshake mode whereby Port A and/or Port B use bits from Port CA's handshake signals
 - **mode 2**- Port A can be set up for bidirectional data transfer using handshake signals from Port C, and Port B can be set up either in mode 0 or mode 1

PA3	1		40	PA4
PA2	2		39	PA5
PA1	3		38	PA6
PA0	4		37	PA7
RD	5		36	WR
CS	6		35	RESET
gnd	7		34	D0
A1	8		33	D1
A0	9		32	D2
PC7	10	8255	31	D3
PC6	11	PPI	30	D4
PC5	12		29	D5
PC4	13		28	D6
PC0	14		27	D7
PC1	15		26	Vcc
PC2	16		25	PB7
PC3	17		24	PB6
PB0	18		23	PB5
PB1	19		22	PB4
PB2	20		21	PB3

Figure 3.2.1 Pin Configuration of 8255

[Source: *Advanced Microprocessors and Microcontrollers* by A.K Ray & K.M.Bhu`rchandi]

The signal description of 8255 is briefly presented as follows:

PA7-PA0: These are eight port A lines that acts as either latched output or buffered input lines depending upon the control word loaded into the control word register.

PC7-PC4: Upper nibble of port C lines. They may act as either output latches or input buffers lines. This port also can be used for generation of handshake lines in mode 1 or mode 2.

PC3-PC0: These are the lower port C lines, other details are the same as PC7-PC4 lines.

PB0-PB7: These are the eight port B lines which are used as latched output lines or buffered input lines in the same way as port A.

RD: This is the input line driven by the microprocessor and should be low to indicate read operation to 8255.

WR: This is an input line driven by the microprocessor. A low on this line indicates write operation.

CS: This is a chip select line. If this line goes low, it enables the 8255 to respond

to RD and WR signals, otherwise RD and WR signal are neglected.

A1-A0: These are the address input lines and are driven by the microprocessor. These lines A1-A0 with RD, WR and CS from the following operations for 8255. In case of 8086 systems, if the 8255 is to be interfaced with lower order data bus, the A0 and A1 pins of 8255 are connected with A1 and A2 respectively.

D0-D7: These are the data bus lines those carry data or control word to/from the microprocessor.

RESET: A logic high on this line clears the control word register of 8255. All ports are set as input ports by default after reset.

8255 BLOCK DIAGRAM:

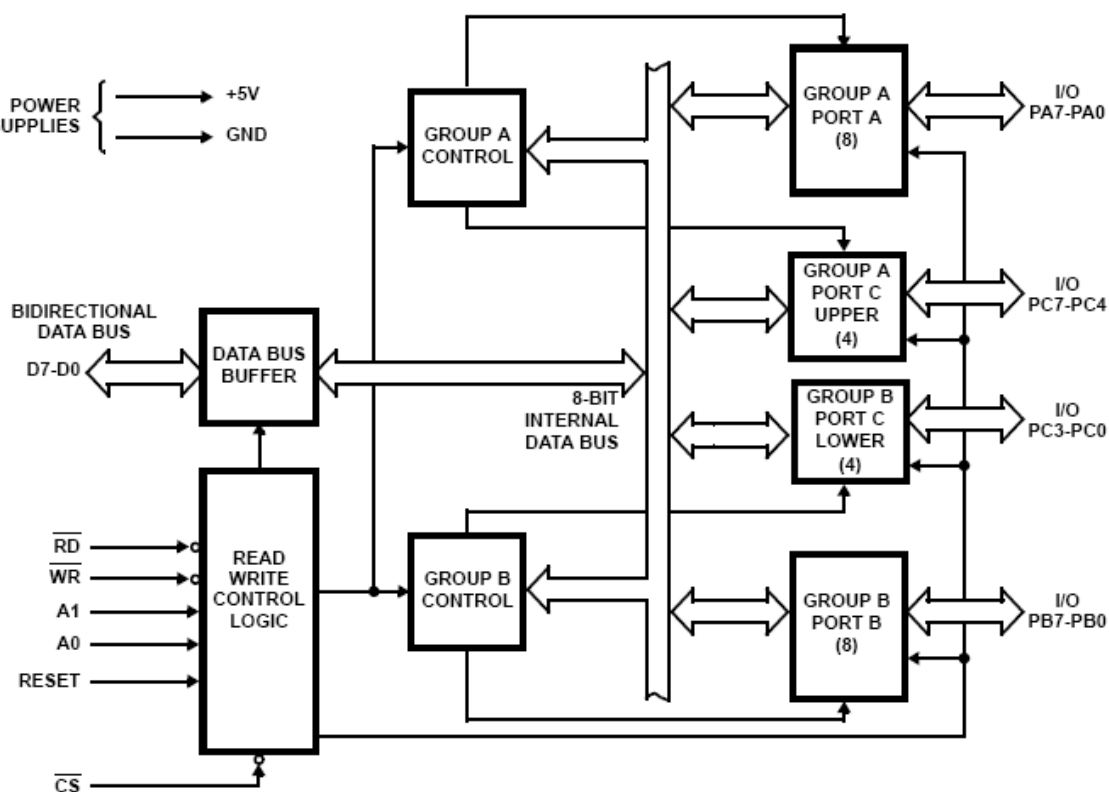


Figure 3.2.2 Block Diagram of 8255

[Source: *Advanced Microprocessors and Microcontrollers* by A.K Ray & K.M.Bhurchandi]

Data Bus Buffer-This three-state bi-directional 8-bit buffer is used to interface the 8255 to the system data bus. Data is transmitted or received by the buffer

upon execution of input or output instructions byte CPU. Control words and status information are also transferred through the data bus buffer.

Read/Write and Control Logic

The function of this block is to manage all of the internal and external transfers of both Data and Control or Status words. It accepts inputs from the CPU Address and Control busses and in turn, issues commands to both of the Control Groups. **A0 and A1** Port Select 0 and Port Select 1. These input signals, in conjunction with the RD and WR inputs, control the selection of one of the three ports or the control word register as shown in **Table 3.2.1**. They are normally connected to the least significant bits of the address bus (A0 and A1).

CS	A1	A0	Selection
0	0	0	Port A
0	0	1	Port B
0	1	0	Port C
0	1	1	Control Register
1	x	x	8255 is not selected

Table 3.2.1 Port / Control Register Selection

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

Group A and Group B Controls

The functional configuration of each port is programmed by the systems software. Each of the Control blocks (Group A and Group B) accepts "commands" from the Read/Write Control logic, receives "control words" from the internal data bus and issues the proper commands to its associated ports.

Ports A, B, and C

The 8255 contains three 8-bit ports (A, B, and C). All can be configured to a wide variety of functional characteristics by the system software but each has its own special features or "personality" to further enhance the power and flexibility of the 8255.

Port A One 8-bit data output latch/buffer and one 8-bit data input latch. Both "pull-up"

And "pull-down" bus-hold devices are present on Port A.

Port B One 8-bit data input/output latch/buffer and one 8-bit data input buffer.

Port C One 8-bit data output latch/buffer and one 8-bit data input buffer (no latch for input).

This port can be divided into two 4-bit ports under the mode control. Each 4-bit port contains a 4-bit latch and it can be used for the control signal output and status signal inputs in conjunction with ports A and B.

OPERATION MODES OF 8255:

The bit pattern loaded in control word register specifies an I/O function for each port and the mode of operation in which the ports are to be used.

There are two different control word formats which specify two basic modes:

| BSR (Bit set reset) mode

| I/O mode

The two basic modes are selected by $D7$ bit of control register. When $D7=1$ it is an I/O mode and when

$D7=0$; it is a BSR mode.

BSR MODE-

- The BSR mode is a port C bit set/reset mode.
- The individual bit of port C can be set or reset by writing control word in the control register.
- The control word format of BSR mode is as shown in the Figure 3.2.3 below:

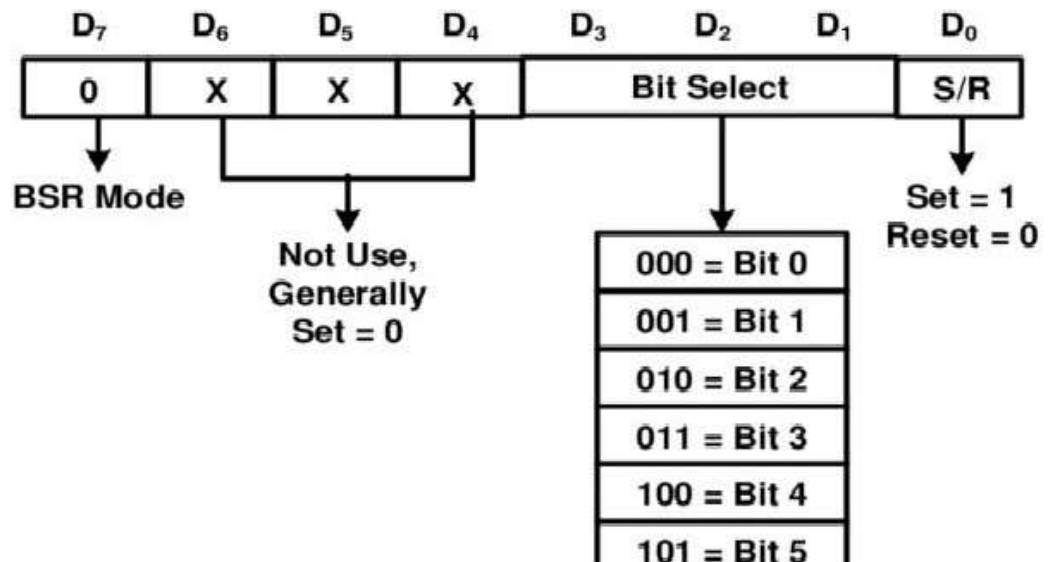


Figure 3.2.3 Control word for BSR Mode

[Source: *Advanced Microprocessors and Microcontrollers* by A.K Ray & K.M.Bhurchandi]

- The pin of port C is selected using bit select bits [b b] and set or reset is decided by bit S/R
- The BSR mode affects only one bit of port C at a time. The bit set using BSR mode remains set unless and until you change the bit. So to set any bit of port C, bit pattern is loaded in control register.
- If a BSR mode is selected it will not affect I/O mode.

I/O MODES

There are three I/O modes of operation:

- | Mode 0- Basic I/O
- | Mode 1- Strobe I/O Mode
- | 2- Bi-directional I/O

The I/O modes are programmed using control register. The control word format of I/O modes is as shown in the Figure 3.2.4 below:

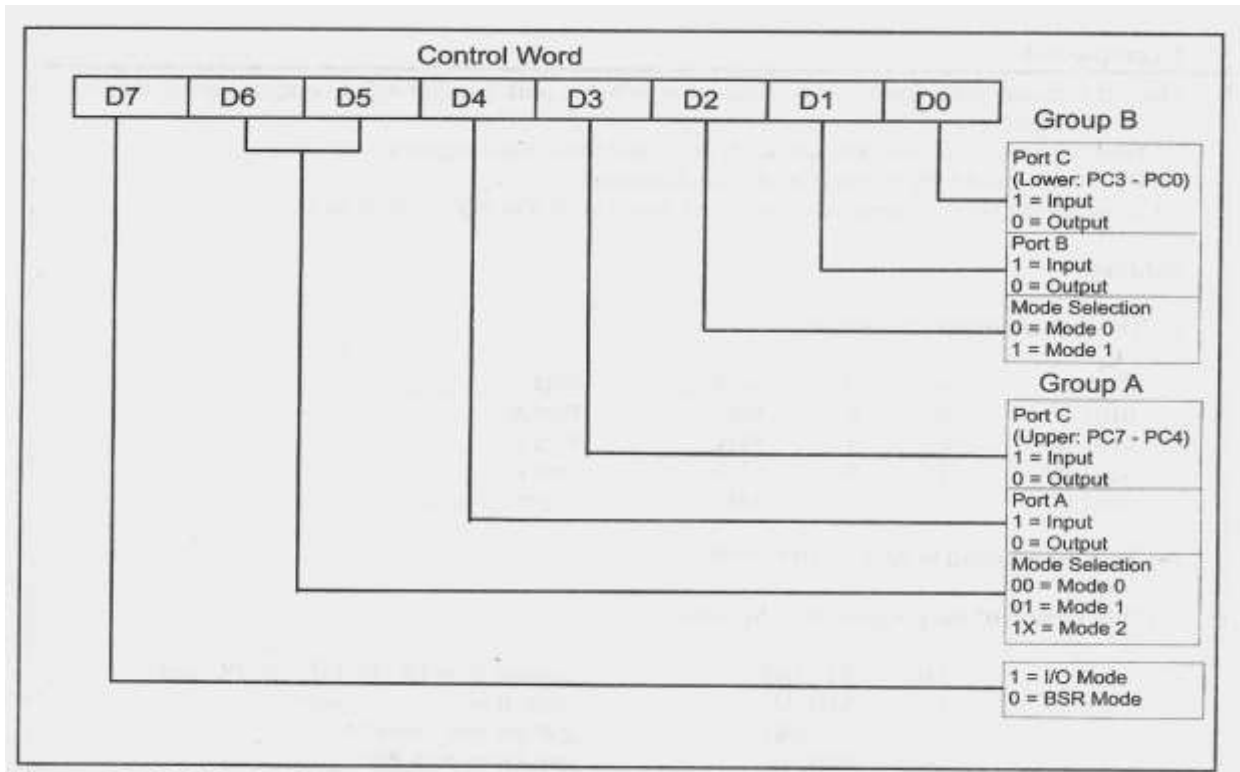


Figure 3.2.4 Control word for I/O Mode

[Source: *Advanced Microprocessors and Microcontrollers* by A.K Ray & K.M.Bhurchandi]

Function of each bit is as follows:

1. $D7$ – When the bit $D7 = 1$ then I/O mode is selected, if $D7=0$ then BSR mode is selected. The function of bits $D0$ to $D6$ is independent on mode (I/O mode or BSR mode).
2. $D6$ and $D5$ -In I/O mode the bits $D6$ and $D5$ specifies the different I/O modes for group A i.e. Mode 0, Mode 1 and Mode 2 for port A and port C upper.
3. $D2$ – In I/O mode the bit $D2$ specifies the different I/O modes for group B i.e. Mode 0 and Mode 1 for port B and port C lower.

All the 3 modes i.e. Mode 0, Mode 1 and Mode 2 are only for group A ports, but for group B only 2 modes i.e. Mode 0 and Mode 1 are provided. When 8255 is reset, it will clear control word register contents and all the ports are set to input mode. The ports of 8255 can be programmed for other modes by

Sending appropriate bit pattern to control register.

Mode 0: Simple Input or Output

In this mode, Port A and Port B are used as two simple 8-bit I/O ports and Port C as two 4-bit I/O ports. Each port (or half-port, in case of Port C) can be programmed to function as simply an input port or an output port. The input/output features in mode 0 are: Outputs are latched, Inputs are not latched. Ports do not have handshake or interrupt capability.

Mode 1: Input or Output with handshake

In mode 1, handshake signals are exchanged between the microprocessor and peripherals prior to data transfer. The ports (A and B) function as 8-bit I/O ports. They can be configured either as input or output ports. Each port (Port A and Port B) uses 3 lines from port C as handshake signals. The remaining two lines of port C can be used for simple I/O functions. Input and output data are latched and Interrupt logic is supported.

Mode 1: Input control signals

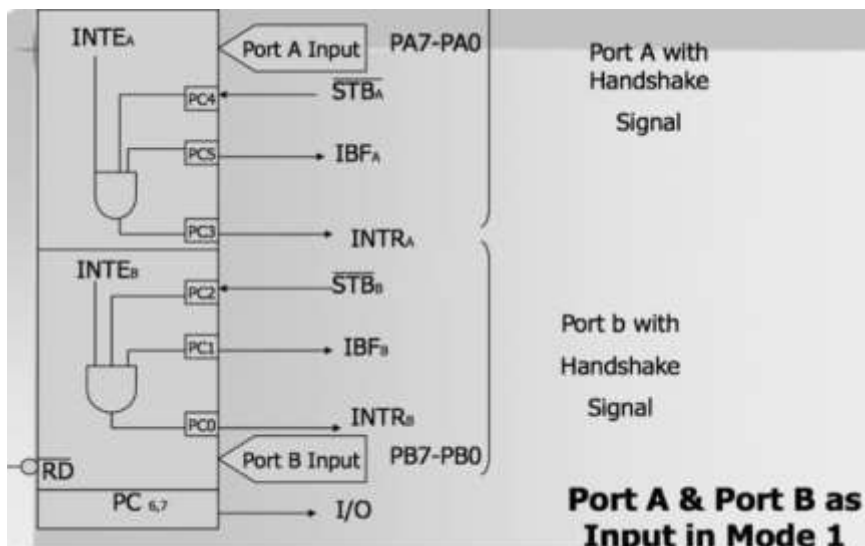


Figure 3.2.5 Input Control Signals

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

STB (Strobe Input): This signal (active low) is generated by a peripheral device that it has transmitted a byte of data. The 8255, in response to, generates IBF and INTR.

IBF (Input buffer full): This signal is an acknowledgement by the 8255 to indicate that the input latches received the data byte. This is reset when the microprocessor reads the data.

INTR (Interrupt Request): This is an output signal that may be used to interrupt the microprocessor. This signal is generated if IBF and INTE are all at logic 1.

INTE (Interrupt Enable): This is an internal flip-flop to a port and needs to be set to generate the INTR signal. The two flip-flops INTEA and INTEB are set/reset using the BSR mode. The INTEA is enabled or disabled through PC4, and INTEB is enabled or disabled through PC2.

Figure 3.2.6 shows the Mode 1 strobe Input Data Transfer.

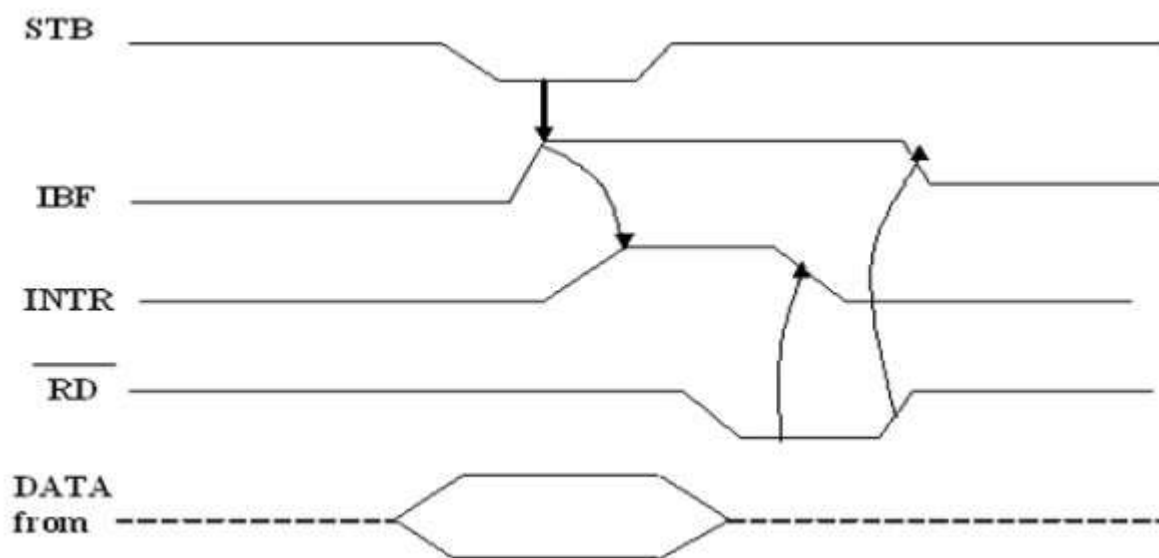


Figure 3.2.6 Mode 1 strobe Input Data Transfer

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

signals from Port C as handshake signals for data transfer. The remaining three

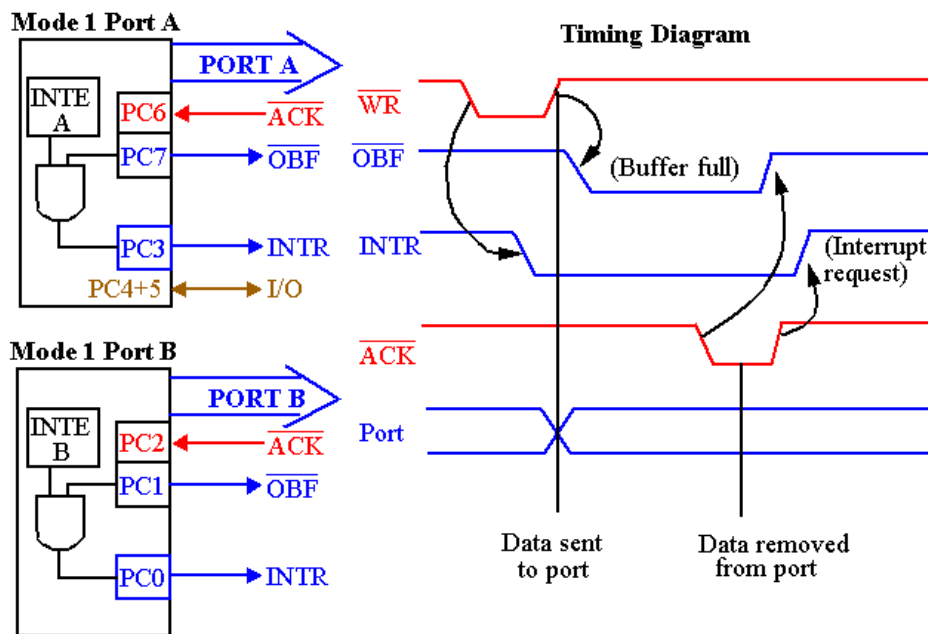


Figure 3.2.7 Output control signals

[Source: *Advanced Microprocessors and Microcontrollers* by A.K Ray & K.M.Bhurchandi]

OUTPUT CONTROL SIGNAL DEFINITION:

OBF (Output Buffer Full): This is an output signal that goes low when the microprocessor writes data into the output latch of the 8255. This signal indicates to an output peripheral that new data is ready to be read. It goes high again after the 8255 receives a signal from the peripheral.

ACK (Acknowledge): This is an input signal from a peripheral that must output a low when the peripheral receives the data from the 8255 ports.

INTR (Interrupt Request): This is an output signal, and it is set by the rising edge of the signal. This signal can be used to interrupt the microprocessor to request the next data byte for output. The INTR is set and INTE are all one and reset by the rising edge of RD signal.

INTEA & INTEB is controlled by bit set/reset of PC6 & PC2 respectively.

Mode 2: Bidirectional Data Transfer

This mode is used primarily in applications such as data transfer between the two computers or floppy disk controller interface. Port A can be configured

3.3 SERIAL COMMUNICATION INTERFACE

PROGRAMMABLE COMMUNICATION INTERFACE (INTEL 8251A)

The 8251 is a programmable chip designed for synchronous and asynchronous serial data communication. USART (Universal Synchronous/Asynchronous Receiver/Transmitter) is the key component for converting parallel data to serial form and vice versa two types of serial data communications are widely used -Asynchronous Communication and synchronous Communication.

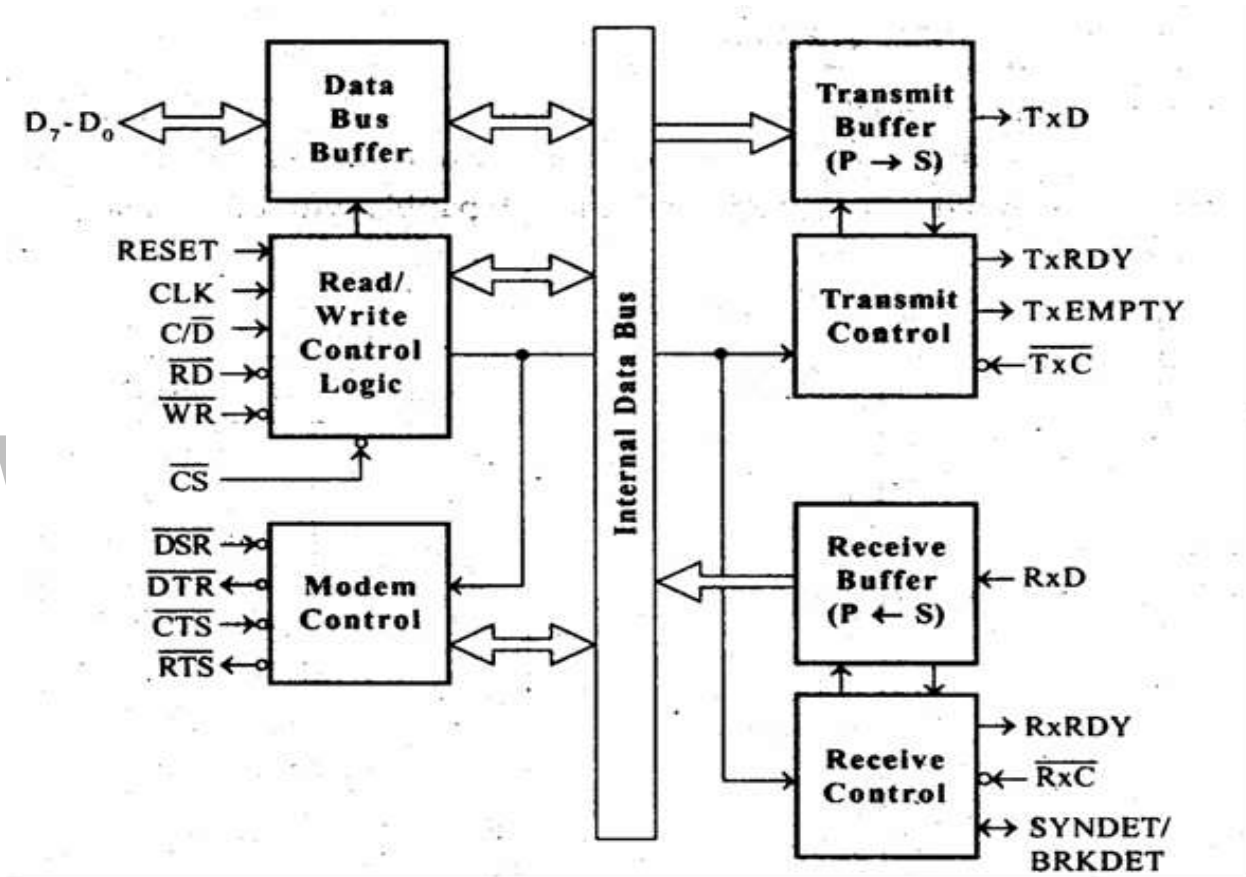


Figure 3.3.1 Block diagram of 8251

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

SIGNAL DESCRIPTION OF 8251

D 0 to D 7 (I/O)

This is bidirectional data bus which receives control words and transmits data from the CPU and sends status words and received data to CPU.

RESET (Input)

A "High" on this input forces the 8251 into "reset status." The device waits for the writing of "mode instruction." The min. reset width is six clock inputs during the operating status of CLK.

CLK (Input)

CLK signal is used to generate internal device timing. CLK signal is independent of RXC or TXC. However, the frequency of CLK must be greater than 30 times the RXC and TXC at Synchronous mode and Asynchronous "x1" mode, and must be greater than 5 times at Asynchronous "x16" and "x64" mode.

WR (Input)

This is the "active low" input terminal which receives a signal for writing transmit data and control words from the CPU into the 8251.

RD (Input)

This is the "active low" input terminal which receives a signal for reading receive data and status words from the 8251.

C/D (Input)

This is an input terminal which receives a signal for selecting data or command words and status words when the 8251 is accessed by the CPU. If C/D = low, data will be accessed. If C/D = high, command word or status word will be accessed.

CS (Input)

This is the "active low" input terminal which selects the 8251 at low level when the CPU accesses.

TXD (output)

This is an output terminal for transmitting data from which serial-converted data is sent out. The device is in "mark status" (high level) after resetting or during a status when transmit is disabled. It is also possible to set the device in "break status" (low level) by a command.

TXRDY (output)

This is an output terminal which indicates that the 8251 is ready to accept a transmitted data character. But the terminal is always at low level if CTS = high or the device was set in "TX disable status" by a command. Note: TXRDY status word indicates that transmit data character is receivable, regardless of CTS or command. If the CPU writes a data character, TXRDY will be reset by the leading edge of WR signal.

TXEMPTY (Output)

This is an output terminal which indicates that the 8251 has transmitted all the characters and had no data character. In "synchronous mode," the terminal is at high level, if transmit data characters are no longer remaining and sync characters are automatically transmitted. If the CPU writes a data character, TXEMPTY will be reset by the leading edge of WR signal.

TXC (Input)

This is a clock input signal which determines the transfer speed of transmitted data. In "synchronous mode," the baud rate will be the same as the frequency of TXC. In "asynchronous mode", it is possible to select the baud rate

factor by mode instruction. It can be 1, 1/16 or 1/64 the TXC. The falling edge of TXC sifts the serial data out of the 8251.

RXD (input)

This is a terminal which receives serial data.

RXRDY (Output)

This is a terminal which indicates that the 8251 contains a character that is ready to READ. If the CPU reads a data character, RXRDY will be reset by the leading edge of RD signal. Unless the CPU reads a data character before the next one is received completely, the preceding data will be lost. In such a case, an overrun error flag status word will be set.

RXC (Input)

This is a clock input signal which determines the transfer speed of received data. In "synchronous mode," the baud rate is the same as the frequency of RXC. In "asynchronous mode," it is possible to select the baud rate factor by mode instruction. It can be 1, 1/16, 1/64 the RXC.

SYNDET/BD (Input or output)

This is a terminal whose function changes according to mode. In "internal synchronous mode," this terminal is at high level, if sync characters are received and synchronized. If a status word is read, the terminal will be reset. In "external synchronous mode," this is an input terminal. A "High" on this input forces the 8251 to start receiving data characters.

In "asynchronous mode," this is an output terminal which generates "high level" output upon the detection of a "break" character if receiver data contains a "low-level" space between the stop bits of two continuous characters. The terminal will be reset, if RXD is at high level. After Reset is active, the terminal will be output at low level.

DSR (Input)

This is an input port for MODEM interface. The input status of the terminal can be recognized by the C PU reading status words.

DTR (Output)

This is an output port for MODEM interface. It is possible to set the status of DTR by a command.

CTS (Input)

This is an input terminal for MODEM interface which is used for controlling a transmit circuit. The terminal controls data transmission if the device is set in "TX Enable" status by a command. Data is transmittable if the terminal is at low level.

RTS (Output)

This is an output port for MODEM interface. It is possible to set the status RTS by a command.

CONTROL WORDS

There are two types of control word.

1. Mode instruction (setting of function)
2. Command (setting of operation)

MODE INSTRUCTION

Mode instruction is used for setting the function of the 8251. Mode instruction will be in "wait for write" at either internal reset or external reset. That is, the writing of a control word after resetting will be recognized as a "mode instruction."

Items set by mode instruction are as follows:

- Synchronous/asynchronous mode

- Stop bit length (asynchronous mode)
- Character length
- Parity bit
- Baud rate factor (asynchronous mode)
- Internal/external synchronization (synchronous mode)
- Number of synchronous characters (Synchronous mode)

The bit configuration of mode instruction is shown in Figure 3.3.2. In the case of synchronous mode, it's necessary to write one-or two byte sync characters. If sync characters were written, a function will be set because the writing of sync characters constitutes part of mode instruction.

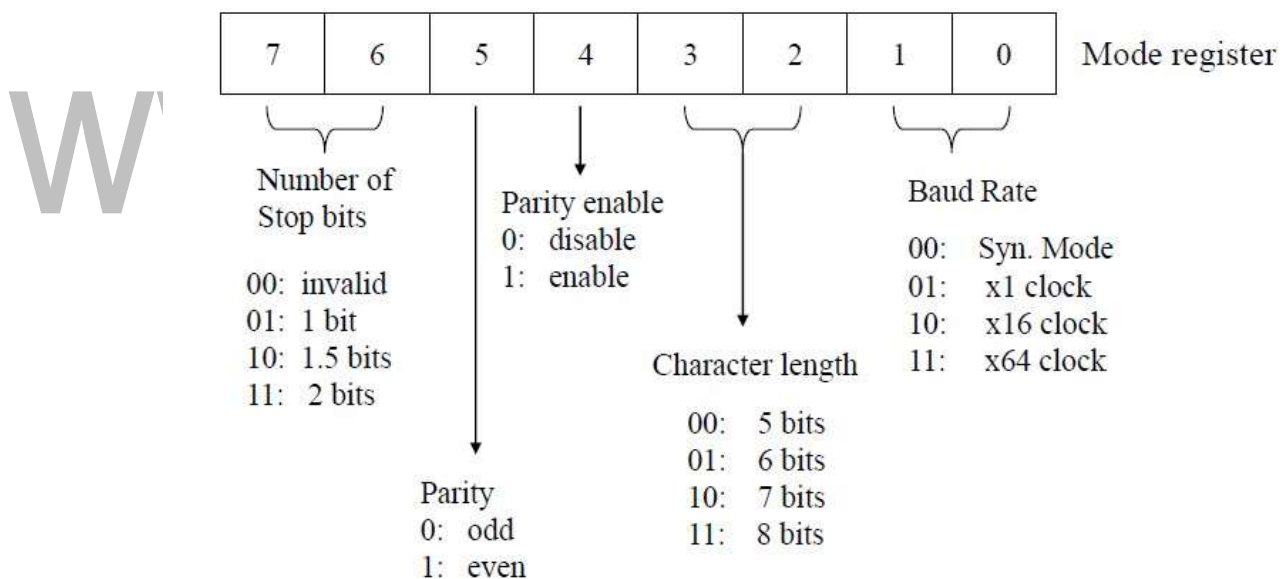


Figure 3.3.2 Mode instruction format-Sync

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

COMMAND

Command is used for setting the operation of the 8251. It is possible to write a command whenever necessary after writing a mode instruction and sync characters. Items to be set by command are as follows:

- Transmit Enable/Disable

- Receive Enable/Disable
- DTR, RTS Output of data.
- Resetting of error flag.
- Sending to break characters
- Internal resetting
- Hunt mode (synchronous mode)

The bit configuration of Command instruction is shown in Figure 3.3.3.

Command Instruction format

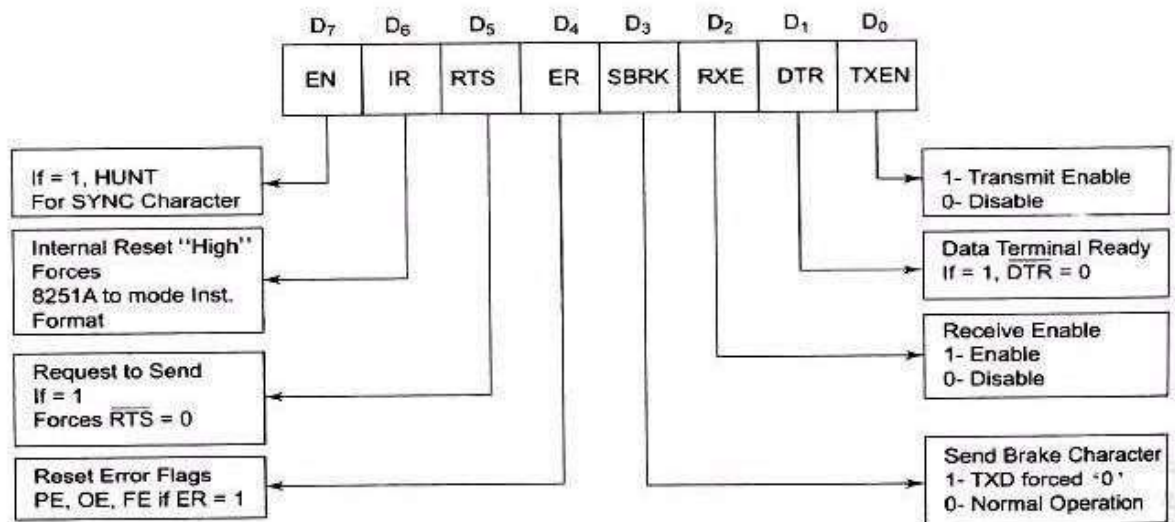


Figure 3.3.3 Command word

[Source: *Advanced Microprocessors and Microcontrollers* by A.K Ray & K.M.Bhurchandi]

Status Word

It is possible to see the internal status of the 8251 by reading a status word. The bit configuration of status word is shown in Figure 3.3.4.

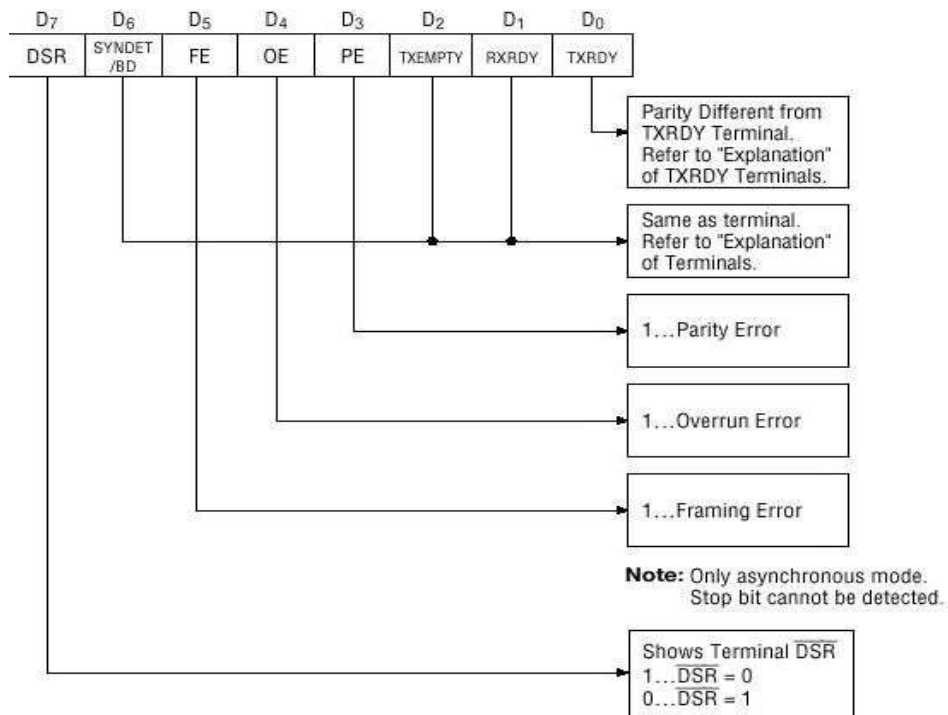


Figure 3.3.4 status word

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

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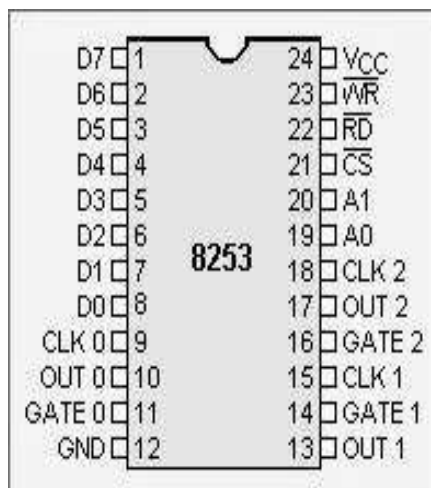
3.5 TIMER

PROGRAMMABLE INTERVAL TIMER (8253/8254)

The Intel 8253 and 8254 are Programmable Interval Timers (PTIs) designed for microprocessors to perform timing and counting functions using three 16-bit registers. Each counter has 2 input pins, i.e. Clock & Gate, and 1 pin for “OUT” output. To operate a counter, a 16-bit count is loaded in its register. On command, it begins to decrement the count until it reaches 0, then it generates a pulse that can be used to interrupt the CPU.

Difference between 8253 and 8254

8253	8254
Its operating frequency is 0 - 2.6 MHz	Its operating frequency is 0 - 10 MHz
It uses N-MOS technology	It uses H-MOS technology
Read-Back command is not available	Read-Back command is available
Reads and writes of the same counter cannot be Interleaved.	Reads and writes of the same counter can be Interleaved.



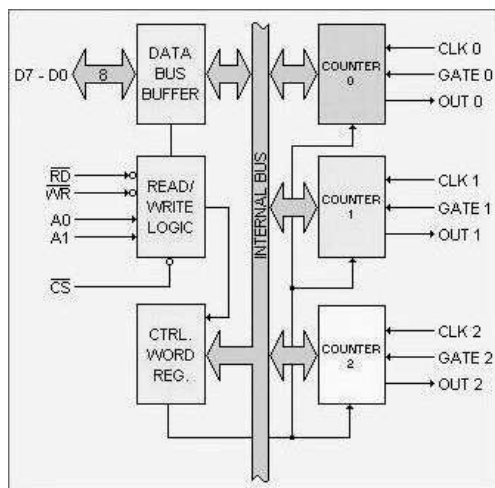


Figure 3.5.1 Internal blocks of 8253 and pin diagram

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

CS - Chip select .When it is low, enables the communication between CPU and 8253.

WR-When it is low, the CPU output data in the form of mode information are loading counters.

RD – When it is low, the CPU reads data.

A0-A1: These pins are connected to address bus. These are used to select one of the three counters.

D0-D7: These are tri-state bidirectional data bus used to interface 8253 to the system data bus.

CLK0, CLK1and CLK2-

These are clock signals for counter0, counter1 and counter2.

GATE0, GATE1 and GATE2-

These are gate terminals for counter0, counter1 and counter2.

OUT0, OUT1and OUT2-

These are output terminals for counter0, counter1 and counter2.

In the above Figure 3.5.1, there are three counters, a data bus buffer,

Read/Write control logic, and a control register. Each counter has two input signals - CLOCK & GATE and one output signal - OUT.

Data Bus Buffer

It is a tri-state, bi-directional, 8-bit buffer, which is used to interface the 8253/54 to the system data bus. It has three basic functions

- | Programming the modes of 8253/54.
- | Loading the count registers.
- | Reading the count values.

Read/Write Logic

It includes 5 signals, i.e. RD, WR, CS and the address lines A0 & A1. In the peripheral I/O mode, the RD and WR signals are connected to IOR and IOW, respectively. In the memory mapped I/O mode, these are connected to MEMR and MEMW.

Address lines A0 & A1 of the CPU are connected to lines A0 and A1 of the 8253/54, and CS is tied to decoded address. The control word register and counters are selected according to the signals on lines A0 & A1.

A1	A0	Selection
0	0	Counter 0
0	1	Counter 1
1	0	Counter 2
1	1	Control Word Register
X	X	No Selection

Table 3.5.1 Selection of Counters

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

COUNTERS

Each counter consists of a single, 16 bit-down counter, which can be operated in either binary or BCD. Its input and output is configured by the selection of modes stored in the control word register. The programmer can read the contents of any of the three counters without disturbing the actual count in process.

Control Word Register:

The bits D7 and D6 of the control word are to select one of the 3 counters. D5 and D4 are for loading /reading the count. D3, D2 and D1 are for the selection of operating mode of the selected counter.

D7	D6	D5	D4	D3	D2	D1	D0
SC1	SC0	RW1	RW0	M2	M1	M0	BCD

SC—Select Counter

SC1	SC0	
0	0	Select Counter 0
0	1	Select Counter 1
1	0	Select Counter 2
1	1	Read-Back Command (see Read Operations)

M—Mode

M2	M1	M0	
0	0	0	Mode 0
0	0	1	Mode 1
X	1	0	Mode 2
X	1	1	Mode 3
1	0	0	Mode 4
1	0	1	Mode 5

RW—Read/Write

RW1	RW0	
0	0	Counter Latch Command (see Read Operations)
0	1	Read/Write least significant byte only
1	0	Read/Write most significant byte only
1	1	Read/Write least significant byte first, then most significant byte

BCD

0	Binary Counter 16-bits
1	Binary Coded Decimal (BCD) Counter (4 Decades)

NOTE:

Don't care bits (X) should be 0 to insure compatibility with future Intel products.

Figure 3.5.2 Control Word format of 8253

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

OPERATION OF 8253:

The functions of the 8253/54 can be described by Write and Read operation.

WRITE Operation:

- Write a control word into control register.
- Load the low-order byte of a count in the counter register.
- Load the high-order byte of count in the counter register.

READ OPERATION:

1. Simple Read: It involves reading a count after inhibiting the counter by controlling the gate input or the clock input of the selected counter, and two I/O read operations are performed by the CPU. The first I/O operation reads the low-order byte, and the second I/O operation reads the high order byte.

2. Counter Latch Command: In the second method, an appropriate control word is written into the control register to latch a count in the output latch, and two I/O read operations are performed by CPU. The first I/O operation reads the low-order byte, and the second I/O operation reads the high order byte.

3. Read-Back Command (Available only for 8254): The third method uses the Read-Back command. This command allows the user to check the count value, programmed Mode, and current status of the OUT pin and Null count flag of the selected counter(s).

8254 MODES OF OPERATION:

1. Mode 0 (Interrupt on terminal count)
2. Mode 1 (programmable Moonshot)
3. Mode 2 (Rate Generator)
4. Mode 3 (Square Wave Generator)
5. Mode 4 (Software Triggered Strobe)

6.Mode 5 (Hardware Triggered Strobe)

The Description and operation of various modes of timer are depicted in the figures below. [Figure 3.5.3(a) to Figure 3.5.3(f)]

MODE 0: INTERRUPT ON TERMINAL COUNT

- In this mode OUT is low.
- Once a count is loaded the counter is decremented after every cycle and when count reaches zero, the OUT goes high.
- This can be used as an interrupt. The OUT remains high until a new count or command word is loaded.

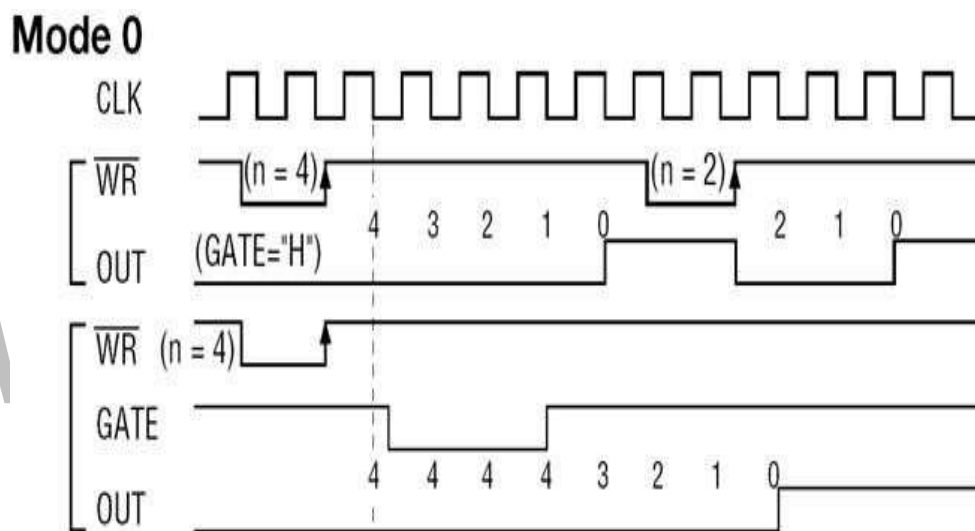


Figure 3.5.3(a) Interrupt on Terminal Count

[Source: *Advanced Microprocessors and Microcontrollers* by A.K Ray & K.M.Bhurchandi]

MODE 1 (PROGRAMMABLE MONO SHOT)

- In this mode OUT is initially high.
- When gate is triggered, the OUT goes low and at the end of count it goes high again, thus generating a one shot pulse.

Mode 1

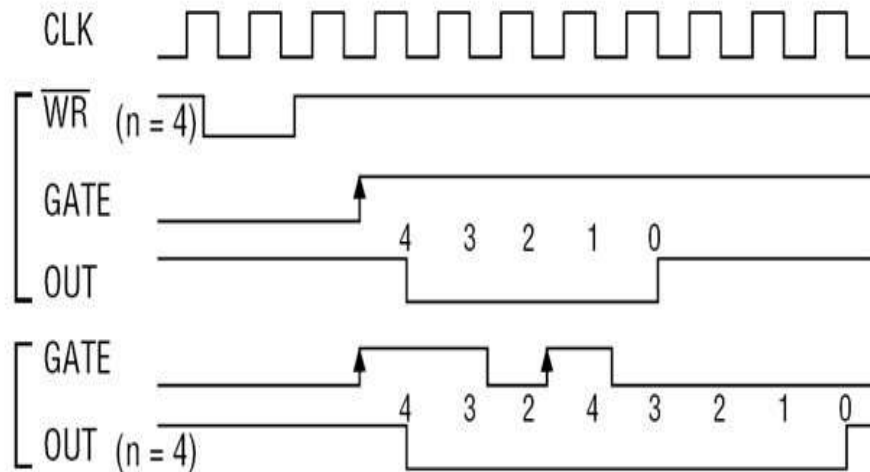


Figure 3.5.3(b) Programmable Mono Shot

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

MODE 2 (RATE GENERATOR)

The mode is used to generate a pulse equal to given clock period at a given interval.

When a count is loaded, the OUT stays high until count reaches 1 and then OUT goes low for 1 clock period then gets reloaded automatically and this is how pulse gets generated continuously.

Mode 2

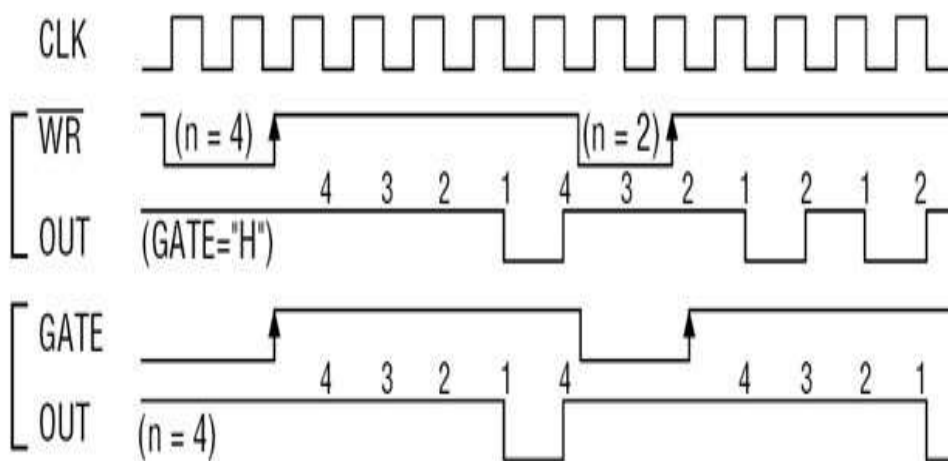


Figure 3.5.3(c) Rate Generator

[Source: Advanced Microprocessors and Microcontrollers by A.K Ray & K.M.Bhurchandi]

MODE 3 (SQUARE WAVE GENERATOR)

- In this a continuous square wave with period equal to count is generated.
- The frequency of square wave = frequency of clock divide by count.
- if count (N) is odd pulse stay high for $(N + 1)/2$ and low for $(N - 1)/2$

Mode 3

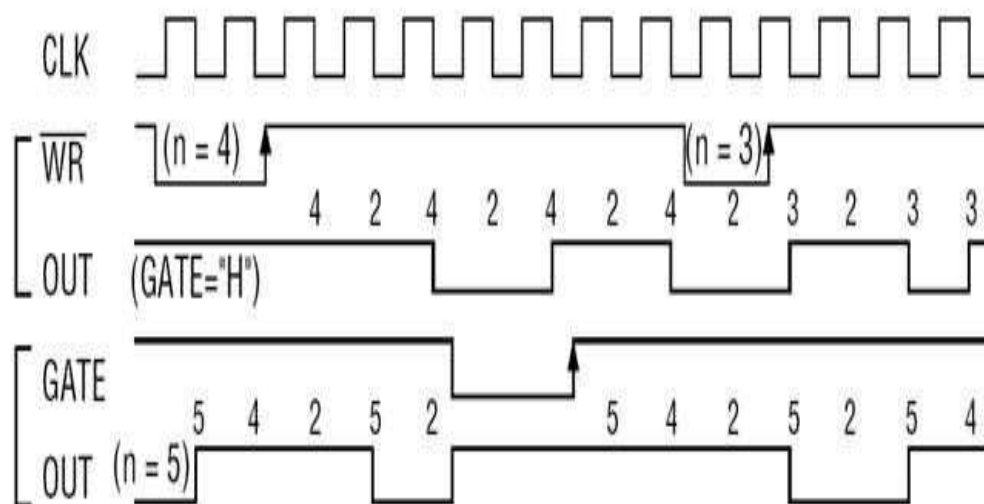


Figure 3.5.3(d) Square Wave Generator

[Source: *Advanced Microprocessors and Microcontrollers* by A.K Ray & K.M.Bhurchandi]

Mode 4 (Software Triggered Strobe)

- In this mode OUT is initially high; it goes low for one clock period at the end of count.
- The count must be reloaded for subsequent outputs.

Mode 4

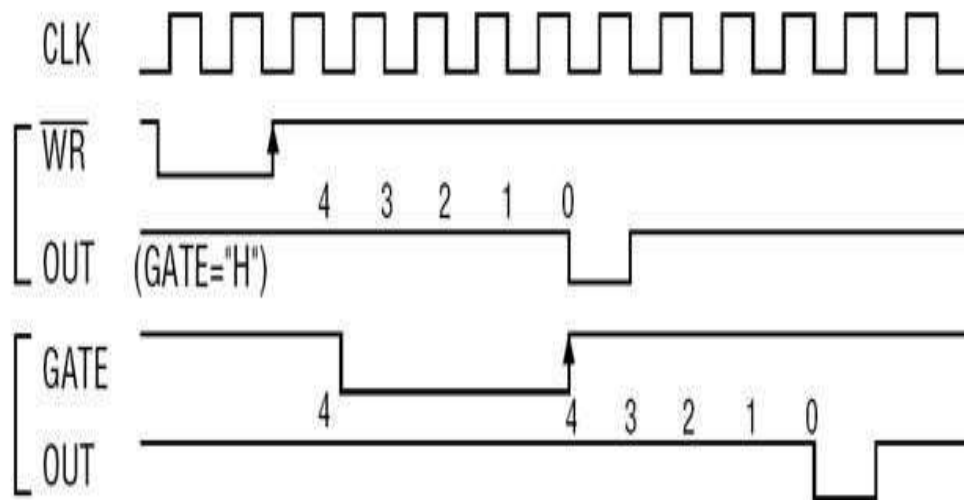


Figure 3.5.3(e) Software Triggered Strobe

[Source: *Advanced Microprocessors and Microcontrollers* by A.K Ray & K.M.Bhurchandi]

Mode 5 (hardware triggered strobe)

- Same as MODE4 except that it is triggered by rising pulse at gate.

Mode 5

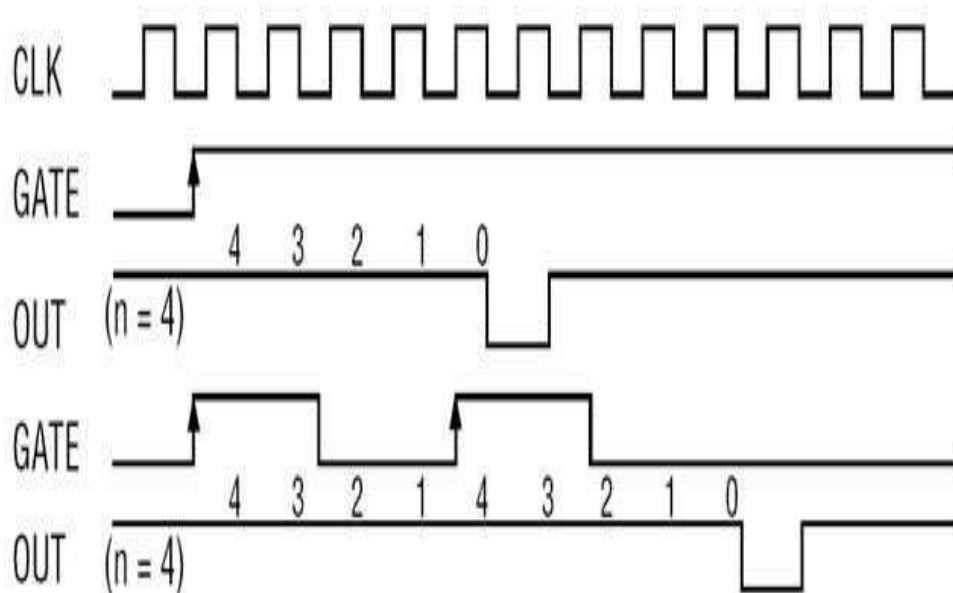


Figure 3.5.3(f) Hardware Triggered Strobe

[Source: *Advanced Microprocessors and Microcontrollers* by A.K Ray & K.M.Bhurchandi]

3.9 TRAFFIC LIGHT CONTROLLER

Traffic light controller interface module is designed to simulate the function of four way traffic light controller. Combinations of red, amber and green LEDs are provided to indicate Halt, Wait and Go signals for vehicles. Combination of red and green LEDs are provided for pedestrian crossing. 36 LEDs are arranged in the form of an intersection.

A typical junction

Is represented in the Figure 3.9.1. At the left corner of each road, a group of five LEDs (red, amber and 3 green) are arranged in the form of a T-section to control the traffic of that road. Each road is named North (N), South(S), East (E) and West (W).

- LED's L1, L10, L19 & L28 (Red) are for the stop signal for the vehicles on the
- L2, L11, L20 & L29 (Amber) indicates wait state for vehicles on the Road N, S, W, & E respectively.
- L3, L4 & L5 (Green) are for left, strait and right turn for the vehicles on road S. Similarly, L12-L13-L14, L23-L22-L21 & L32-L31-L30 simulates same function for the roads E, N, W respectively.
- A total of 16 LED's (2 Red & 2 Green at each road) are provided for pedestrian crossing. L7-L9, L16-L18, L25-L27 & L34-L36 (Green) when ON allows pedestrians to cross and L6- L8, L15-L17, L24-L26 & L33-L35 (Red) when ON alarms the pedestrians to wait.
- To minimize the hardware pedestrian's indicator LEDs (both red and green are connected to same port lines (PC4 to PC7) with red inverted.

- Red LEDs L10 & L 28 are connected to port lines PC2 & PC3 while L1 & L19 are connected to lines PC0 & PC1 after inversion. All other LED's (amber and green) are connected to port A & B.

WORKING:

8255 is interfaced with 8086 in I/O mapped I/O and all ports are output ports. The basic operation of the interface is explained with the help of the enclosed program. The enclosed program assumes no entry of vehicles from North to West, from road East to South.

At the beginning of the program all red LEDs are switched ON, and all other LEDs are switched OFF. Amber LED is switched ON before switching over to proceed state from Halt state.

The sequence of traffic followed is given below.

- From road north to East, from road east to north, from road south to west from road west to south, from road west to north.
- From road north to East, from road south to west, from road south to north, from road south to east, from road north to south, from road south to north.
- Pedestrian crossing at roads west & east.
- From road east to west, from road west to east, pedestrian crossing at roads north & south.

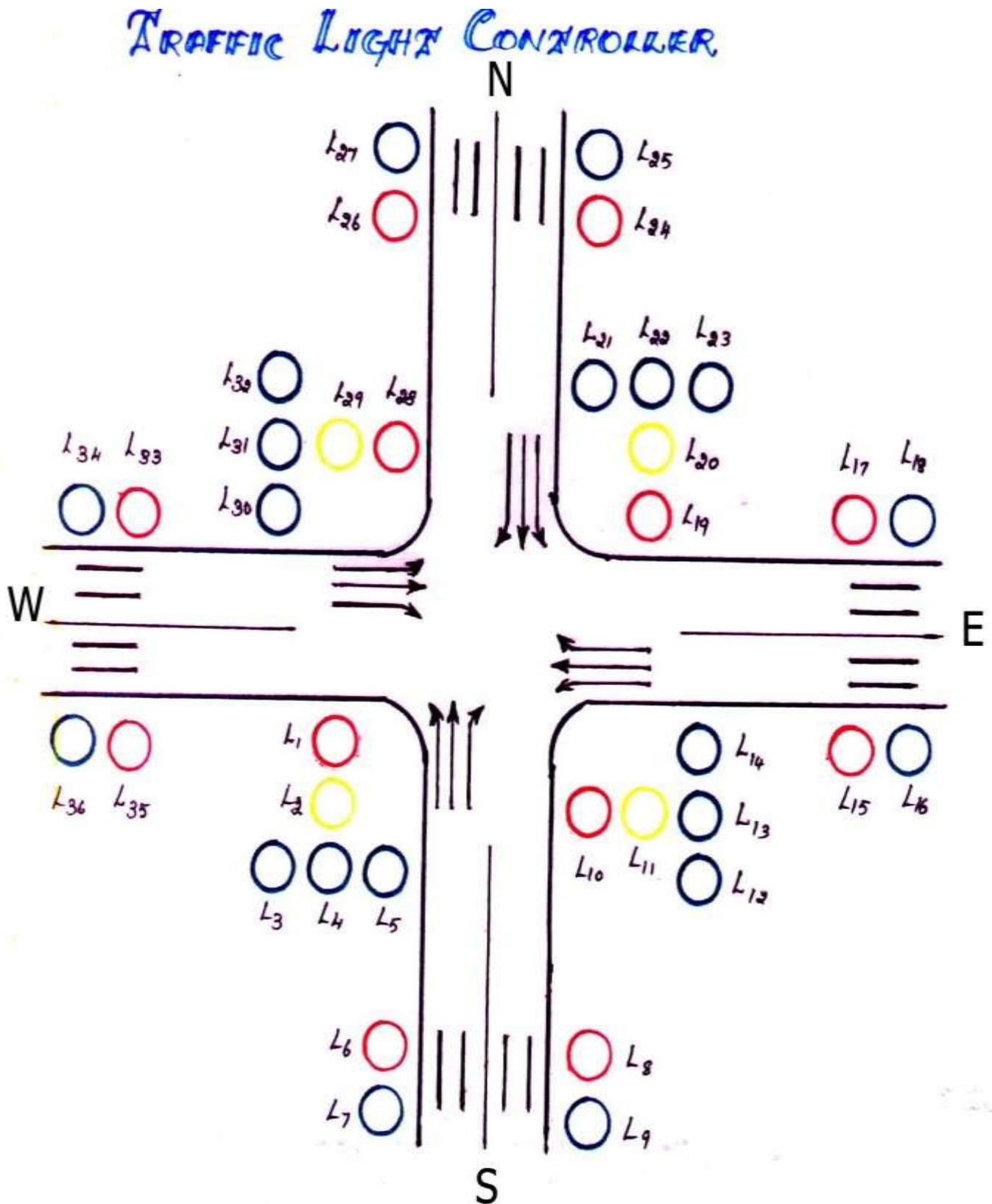


Figure 3.9.1 Traffic Light Junction with arrangement of LEDs

PROGRAM:

ADDRESS	OPCODE	LABEL	MNEMONICS
1000	B0 80	Start	Mov AL,80H
1002	E6 26		OUT CNTRL,AL
1004	BB 6B 10	REPEAT	MOV BX,LOOK UP
1007	BE 77 10		MOV SI,LABEL
100A	E8 32 00		CALL OUT
100D	8A 04		MOV AL,[SI]
100F	E6 20		OUT 20,AL
1011	E8 4A 00		CALL DELAY1
1014	46		INC SI
1015	43		INC BX
1016	E8 26 00		CALL OUT
1019	8A 04		MOV AL,[SI]
101B	E6 22		OUT 22,AL
101D	E8 3E 00		CALL DELAY1
1020	46		INC SI
1021	43		INC BX
1022	E8 1A 00		CALL OUT
1025	8A 04		MOV AL,[SI]
1027	E6 24		OUT 24,AL
1029	E8 32 00		CALL DELAY1
102C	46		INC SI
102D	43		INC BX
102E	E8 0E 00		CALL OUT
1031	8A 04		MOV AL,[SI]
1033	E6 24		OUT 24,AL
1035	46		INC SI
1036	8A 04		MOV AL,[SI]
1038	E6 20		OUT 22,AL
103A	E8 21 00		CALL DELAY1
103D	EB C5		JMP REPEAT
103F	8A 07	OUT	MOV AL,[BX]
1041	E6 24		OUT 24,AL
1043	43		INC BX
1044	8A 07		MOV AL,[BX]
1046	E6 22		OUT 22,AL
1048	43		INC BX
1049	8A 07		MOV AL,[BX]
104B	E6 20		OUT 20,AL
104D	E8 01 00		CALL DELAY

			RET
1050	C3		RET
1051	BF 40 00	DELAY	MOV DI,00040H
1054	BA FF FF	A	MOV DX,0FFFFH
1057	4A	A1:	DEC DX
1058	75 F6		JNZ A1
105A	4F		DEC DI
105B	75 F6		JNZ A
105D	C3		RET
105E	BF 15 00	DELAY1:	MOV DI,00015H
1061	BA FF FF		MOV DX,0FFFFH
1064	4A		DEC DX
1065	75 FD		JNZ B1
1067	4F		DEC DI
1068	75 F6		JNZ B
106A	C3		RET

LOOK UP TABLE 1:

ADDRESS	OPCODE		DATA
106B	12 27 44 10	LOOK UP	DB 12H,27H,44H,10H
106F	2B 92 10 9D		2BH,92H,10H,9DH
1073	84 48 2E 84		84H,48H,2EH,84H

LOOK UP TABLE 2:

ADDRESS	OPCODE	LABEL:	DATA
107B	48 4B 20 49		DB 48H 4BH,20H,49H,04H
107C	04		END