8251 AND 8253

PROGRAMMABLE COMMUNICATION INTERFACE AND PROGRAMMABLE INTERVAL TIMER

1. INTRODUCTION

Electro System Associates Private Limited (ESA) manufactures trainers for most of the popular microprocessors like 8085, Z-80, 8031,8086/88,68000 and 80196. ESA offers a variety of modules, which can be interfaced, to these trainers. These modules can be effectively used for teaching/training in the laboratories.

The 8251 and 8253 study card incorporates Intel's 8251 and 8253. The interface is designed to explain all the facilities available in 8251 and 8253.

Functional description of 8251 and 8253, implementation of the circuit and some simple software are presented in this manual.

2. DESCRIPTION OF THE CIRCUIT:

The study card provides 8251 as well as timer section. The interface has got 4 connectors.
J3,J4 and P1 used for various trainer kits. J2 (10 pin FRC right angle male connector) is used for connecting RS232C cable to the COM port of the system. 10 RED LEDs are provided to indicate the important signals. 6.144MHz crystal is provided to drive 1.5 MHz clock.

The following table describes the various hardware configurations for 8251 and 8253 using jumper settings.

Jumper	Position	Description
JP1	1-2 *2-3	GATE1 is connected externally. GATE1 is connected to VCC.
JP2	1-2 *2-3	GATE2 is connected externally. GATE2 is connected to VCC.
JP3	1-2 *2-3	CLK1 is derived externally. 1.5 Mhz clock is given to CLK1.
JP4	1-2 *2-3	OUT1 is given to CLK2. CLK2 is derived externally.
JP5	OPEN *CLOSED	CLK0 is left unconnected. 1.5Mhz clock is given to CLK0.
JP6	*OPEN CLOSED	RxD and TxD are not shorted. RxD and TxD are shorted.
JP7	*OPEN CLOSED	CTS and RTS are not shorted. CTS and RTS are shorted.
JP8	*OPEN CLOSED	8251 chip select derived from decoder. 8251 chip select derived externally.

3.0 INSTALLATION:

Please refer the below table for connection procedure for various trainer kits.

Sl. No	Model No.	Studycard Adapter	Connection Procedure
1	MPS 85-3	No Adapter	Connect 26 pin FRC cables between J3, J4 of study card with J3 ,J4 of the trainer kit respectively.
2	ESA 85-2	No Adapter	Connect 50 pin FRC cable between P1 of study card with P1 of the trainer kit .
3	ESA 86/88-2	Study card adapter for ESA 86-2/3 trainer	Connect 50 pin FRC cables between J1, J2 of the adapter with J1,J2 of the trainer kit. Connect 26 pin FRC cables between J3,J4 of the adapter with J3,J4 of the study card respectively.
4	ESA 86/88-3	Study card adapter for ESA 86-2/3 trainer	Connect 50 pin FRC cables between J1, J2 of the adapter with J1,J2 of the trainer kit. Connect 26 pin FRC cables between J3,J4 of the adapter with J3,J4 of the study card respectively.
5	ESA 86E	No Adapter	Connect 26 pin FRC cables between J3, J4 of study card with J6 ,J7 of the trainer kit respectively.
6	ESA 31	Study Card adapter ESA 31/51 Trainer	Connect 50 pin FRC cable between J1 of adapter with J5 of the trainer kit. Connect 26 pin FRC cables between J3,J4 of adapter with J3,J4 of the study card respectively.
7	ESA 51	Study Card adapter ESA 31/51 Trainer	Connect 50 pin FRC cable between J1 of adapter with J1 of the trainer kit. Connect 26 pin FRC cables between J3,J4 of adapter with J3,J4 of the study card respectively.
8	ESA 51E	ESA 51E Study card adapter.	Connect 50 pin FRC cable between P3 of adapter with P1 of study card. Connect 26 pin FRC cables between J3 ,J4 of adapter with J4,J6 of the trainer kit respectively.

The 8251A programmable communication interface

The 8251A is a programmable chip designed for synchronous and a synchronous serial data communication, packaged in a 28 – pin DIP. The 8251A is the enhanced version of its predecessor, the 8251, and it is compatible with the 8251. Figure1 shows the block diagram of the 8251A. It includes 5 sections: Read/Write Control Logic, Transmitter, Receiver, Data Bus Buffer, and Modem Control.

The control logic interfaces the chip with the MPU, determines the function of the chip according to the control word in its register (to be explained below), and monitors the data flow. The transmitter section converts a parallel word received from the MPU into serial bits and transmits them over the TxD line to a peripheral. The receiver section receives serial bits from a peripheral, converts them into a parallel word, and transfers it to MPU. The 8251A is a complex device capable of performing various functions. For the sake of clarity, this chapter focuses only on the asynchronous mode of serial I/O, and excludes any discussion of the synchronous mode and the modem control. The asynchronous mode is often used for the data communication between the MPU and serial peripherals such as terminals and floppy disks.

Figure 2 shows an expanded version of the 8251A block diagram. The block diagram shows all the elements of a programmable chip; It includes the interfacing signals, the control register, and the status register. The functions of the various blocks are described below.

READ/WRITE CONTROL LOGIC AND REGISTERS

This section includes R/W control logic, six input signals, control logic and three buffer registers: data register, control register, and status register. The input signals to the control logic are as follows.

Input signals

- **CS*-chip select:** When this signal goes low, the 8251A is selected by the MPU for communication. This is usually connected to a decoded address bus.

- **C/D***-control/data: when this signal is high, the control register or the status register is addressed. The control register and the status register are differentiated by WR* and RD* signals, respectively.

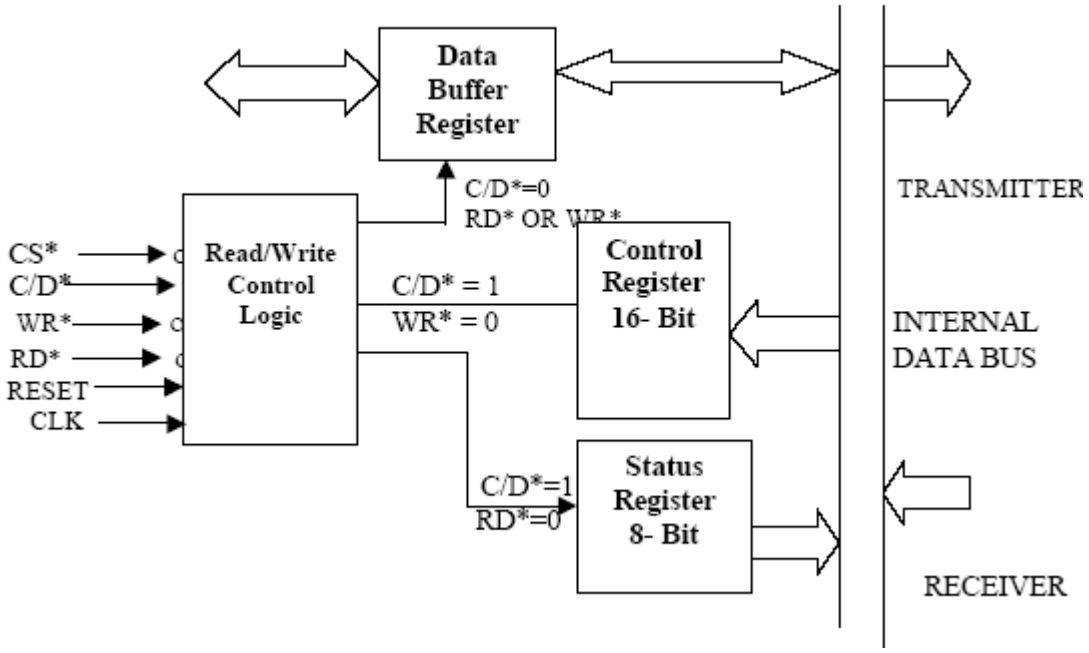


FIGURE 2: The 8251A: Expanded Block Diagram of Control Logic and Registers

- **WR*-Write:** When this signal goes low, the MPU either writes in the control register or sends output to the data buffer. This is connected to IOW* or MEMW*.
- **RD*-Read:** When this signal goes low, the MPU either reads a status register or accepts (input) data from the data buffer. This is connected to either IOR* or MEMR*
- **RESET-Reset**: A high on this input resets the 8251A and forces it into the idle mode.
- **CLK-Clock**: This is the clock input, usually connected to the system clock. This clock does not control either the transmission or the reception rate. The clock is necessary for communication with the microprocessor.

Control Register This 16-bit register for a control word consists of two independent bytes: the first byte is called the **mode instruction** (word) and the second byte is called **command instruction** (word). This register can be accessed as an output port when the C/D* pin is high.

Status Register: This input register checks the ready status of a peripheral. This register is addressed as an input port when the C/D* pin is high, it has the same port address as the control register.

Data Buffer :This bi-directional register can be addressed as an input port and output port when the C/D* pin is low. Table 1 summarizes all the interfacing and control signals.

CS*	C/D*	RD*	WR*	Function
0	1	1	0	MPU writes instructions in the control register.
0	1	0	1	MPU reads status from the status register
0	0	1	0	MPU outputs data to the Data Buffer
0	0	0	0	MPU accepts data from the Data Buffer
1	X	X	X	USART is not selected.

TRANSMITTER SECTION

The transmitter accepts parallel data from the MPU and converts them into serial data . It has two registers: a buffer register to hold eight bits and an output register to convert eight bits into steam of serial bits (figure 3) .the MPU writes a byte in the buffer register . whenever the output register is empty, the contents of the buffer register are transferred to the output register. This section transmits data on TxD pin with the appropriate framing bits (START and STOP) . Three output signals and one input signal are associated with the transmitter section.

TxD-Transmit Data: Serial bits are transmitted on this line.

TxC*-Transmitter Clock: This input signal controls the rate at which the bits are transmitted by the USART.The clock frequency can be 1,16 or 64 times the baud.

TxRDY-transmitter Ready: This is the output signal. When it is high, it indicates the buffer register is empty and USART is ready to accept a byte .It can be used either to interrupt the MPU or to indicate the status. This signal is reset when a data byte is loaded into the buffer.

TxE-Transmitter Empty: This is an output signal. Logic 1 on this indicates the output register is empty. This signal is reset when a byte is transferred from the buffer to the output register.

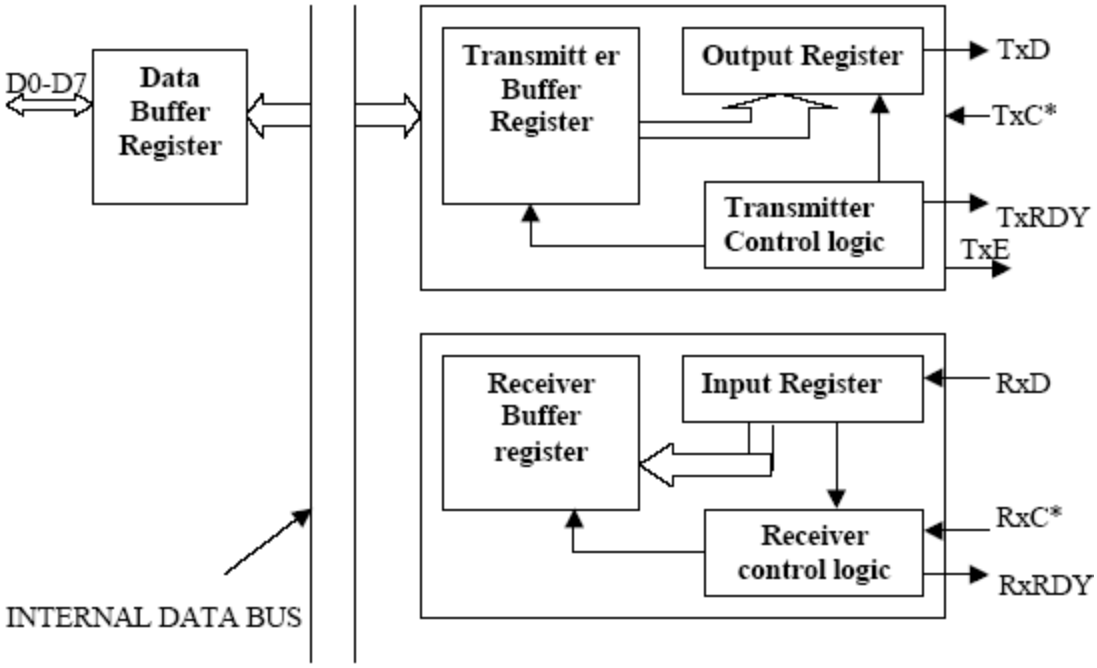


FIGURE 3

The 8251A: Expanded Block Diagram of Transmitter and Receiver Section

RECEIVER SECTION

The receiver accept serial data on the RxD line from a peripheral and converts them into parallel data . The section has two registers: the receiver input register and the buffer register (figure 3).

When the RxD line goes low, the control logic assumes it is a START bit , waits for half a bit time , and sample the line again. If the line is still low , the input register accepts the following bits, form a character ,and load it into the buffer register. Subsequently, the parallel byte is transferred to the MPU when requested. In the asynchronous mode , two input signal and one output signal are necessary ,as described below.

RxD-Receive Data: Bits are received serially on this line and converted into a parallel byte in the receiver input register.

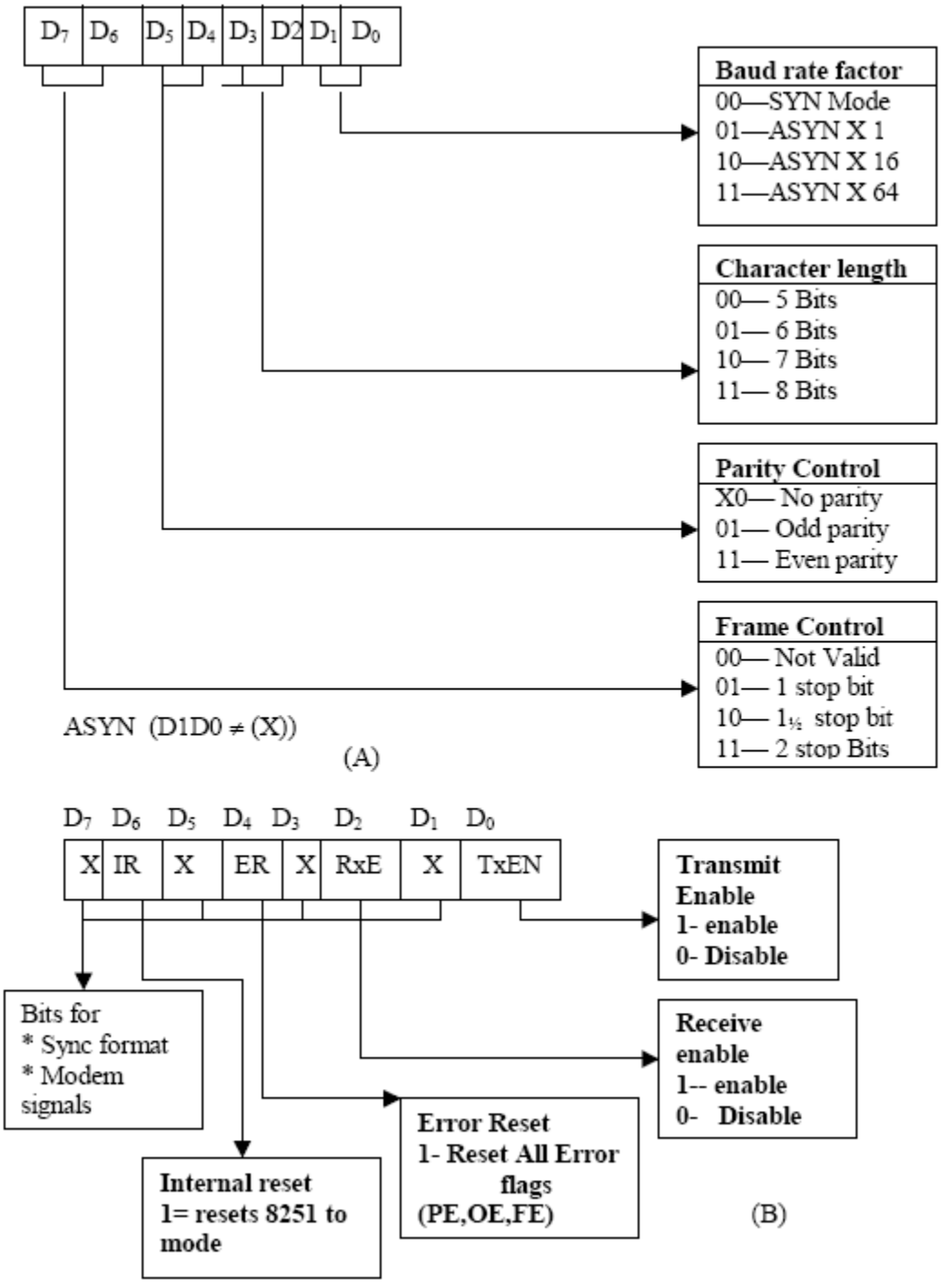
RxC-Receiver clock: This is a clock signal that controls the rate at which bits are received by the USART. In the asynchronous mode, the clock can be set to 1,16 or 64 times the baud.

RxRDY-Receiver Ready: This is an output signal. It goes high when the USART has a character in the buffer register and is ready to transfer into the MPU. This line can be used either to indicate the status or to interrupt the MPU

INITIALIZING THE 8251A

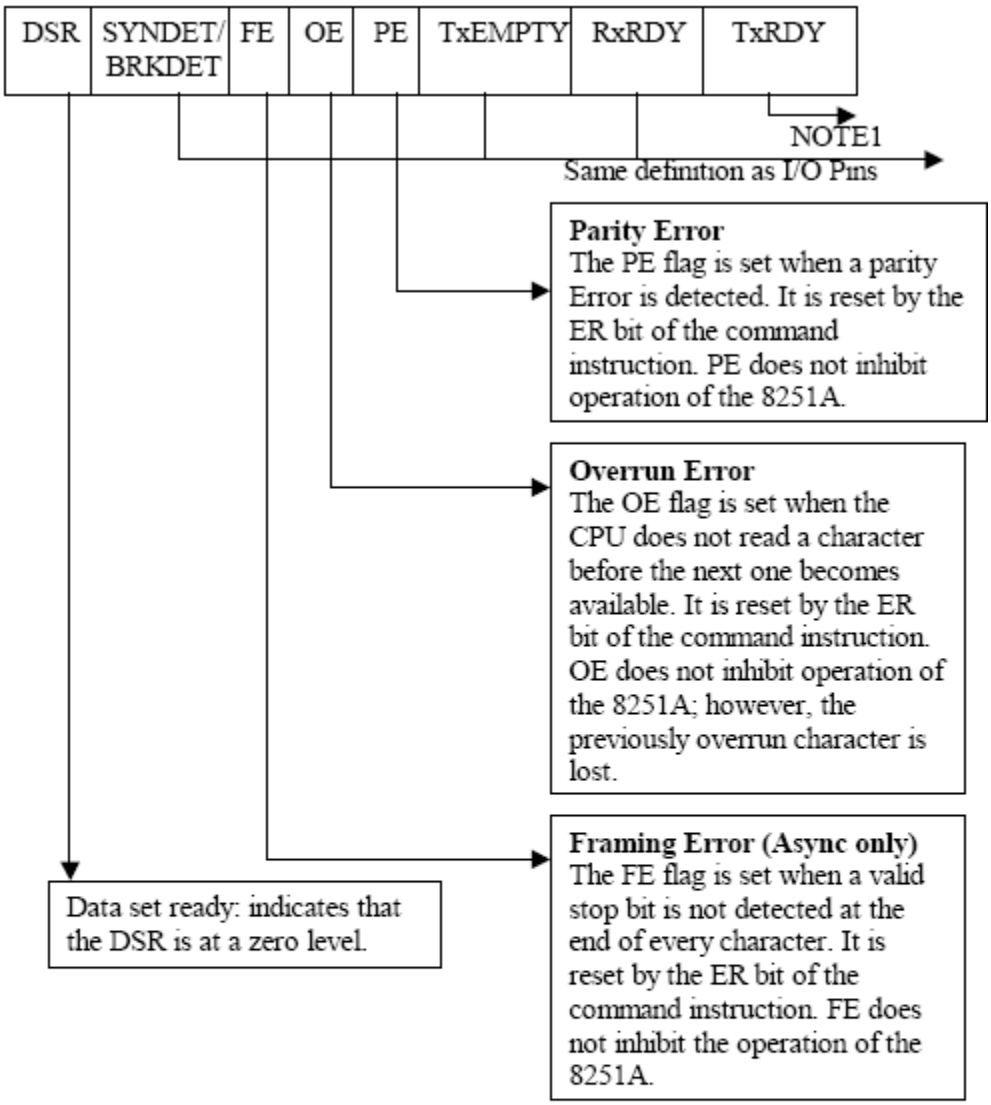
To implement serial communication, the MPU must inform the 8251A of all details such as mode, baud, stop bits, parity, etc. Therefore, prior to data transfer, a set of control words must be loaded into the 8 -bit control register of the 8251A. In addition, the MPU must check the readiness of the peripheral by reading the status register. The control words are divided into two formats: mode words and command words. The mode word specifies the general characteristics of operation (such as baud , parity, number of stop bits),the command word enable data transmission and /or reception, and the status word provides the information concerning register status and transmission errors. Figure 4 shows the definition of these words.

To initialize the 8251A in the asynchronous mode, a certain sequence of control words must be followed. After a Reset operation (system Reset or through instruction), a mode word must be written in the control register followed by a command word. Any control word written in the control register immediately after a word will be interpreted as a command word ,that means a command word can be changed any time during the operation. However, the 8251A should be reset prior to writing a new mode word, and it can be reset by using the Internal Reset bit (D6) in the command word.



Note: * indicates active low signal

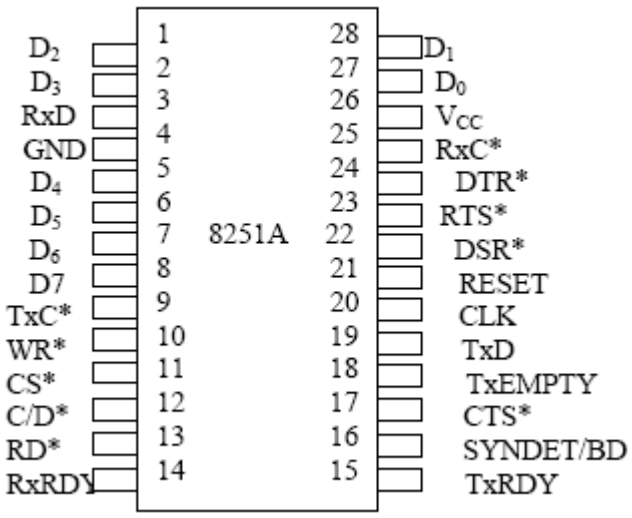
FIGURE 4
Mode Word Format (A),Command Word Format (B) and Status word Format (C)



NOTE1: TxRDY status bit has different meanings from the TxRDY output pin. The former is not conditioned by CTS* And TxEN; the latter is conditioned by both CTS* and TxEN. i.e. TxRDY status bit = DB buffer empty TxRDY pin out = DB buffer empty (CTS*=0). (TxEN=1)

(C)

Pin Configuration



D_7-D_0	Data Bus (8 bits)
C/D*	Control or Data is to be Written or Read
RD*	Read Data Command
WR*	Write Data or Control Command
CS*	Chip Enable
CLK	Clock Pulse(TTL)
RESET	Reset
TxC*	Transmitter Clock
TxD*	Transmitter Data
RxC*	Receiver Clock
RxD	Receiver Data
RxRDY	Receiver Ready
TxRDY	Transmitter Ready
DSR*	Data Set Ready
DTR*	Data Terminal Ready
Syndet/BD	sync detect/ break detect
RTS*	Request to send data
CTS*	clear to send data
TxE	transmitter empty
Vcc	+5 volt supply

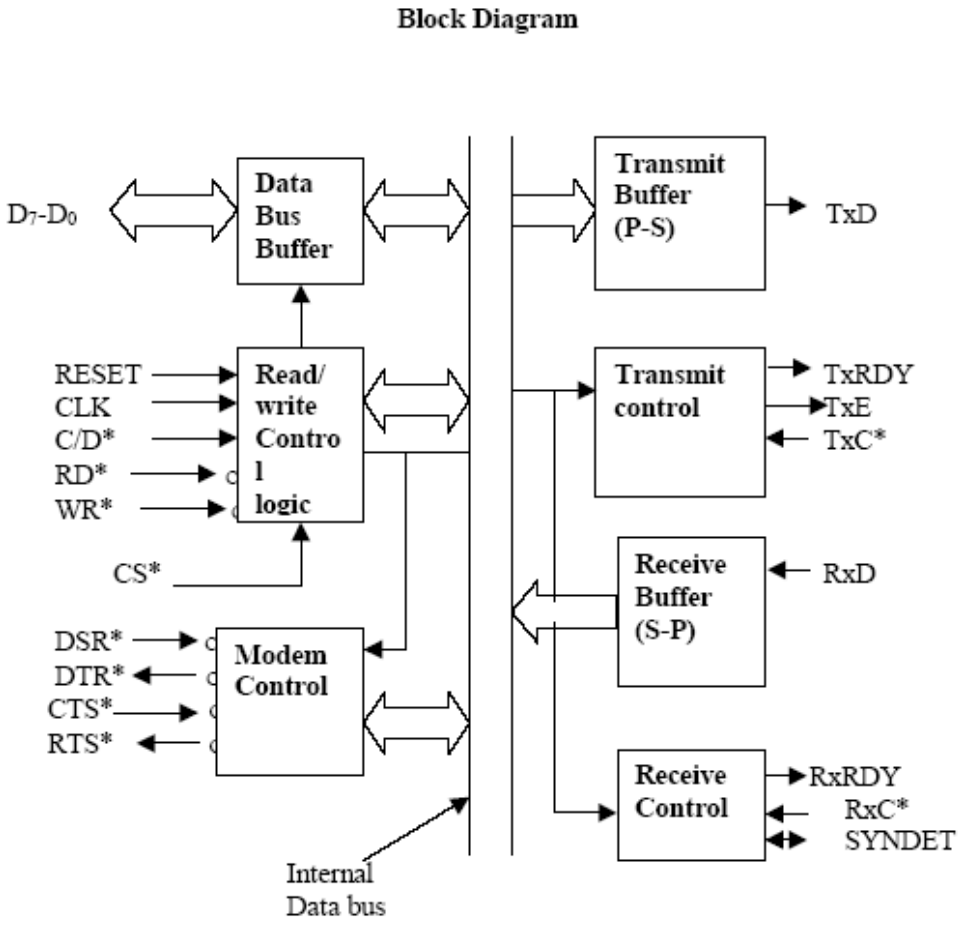


FIGURE 1
The 8251 A: Block Diagram, Pin Configuration and Description.

8253 / 8253-5

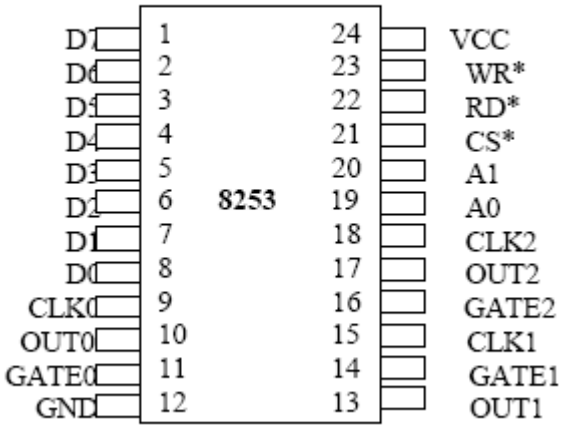
PROGRAMMABLE INTERVAL TIMER

- **MCS-85™ Compatible 8253-5**
- **3 Independent 16-Bit Counter**
- **DC to 2 MHz**
- **Programmable Counter Modes**
- **Count Binary or BCD**
- **Single +5V Supply**
- **24-Pin dual In –line Package**

The Intel ® 8253 is a programmable counter/timer chip designed for use as an Intel microcomputer peripheral. It uses nMOS technology with a single +5V supply and is packaged in a 24 pin plastic DIP.

It is organized as 3 independent 16 bit counters, each with a count rate of up to 2 Mhz. All modes of operation are software programmable.

PIN CONFIGURATION



FUNCTIONAL DESCRIPTION

General

The 8253 is a programmable interval timer/counter specifically designed for use with the Intel™ microcomputer systems. Its function is that of a general purpose ,multi-timing element that can be treated as an array of I/O ports in the system software.

The 8253 solves one of the most common problems in the microcomputer system , the generation of accurate time delays under software control. Instead of setting up timing loops in system software ,the programmer configures the 8253 to match his requirements, initialize one of the counter of 8253 with the desired quantity , then upon command the 8253 will count out the delay and interrupt the CPU when it has completed its tasks it is easy to easy to see that the software overhead is minimal and that multiple delays can easily be maintained by assignment of priority levels.

Other counter / timer functions that are non delay in nature but also common to most microcomputers can be implemented with the 8253.

- Programmable Rate Generator
- Event Counter
- Binary rate multiplier
- Real Time Clock
- Digital One -shot
- Complex Motor controller

Data Bus Buffer

This 3-state, bi-directional, 8-bit buffer is used to interface the 8253 to the system data bus. Data is transmitted or received by the buffer upon execution of IN put or OUT put CPU instructions. The Data Bus Buffer has three basic functions

1. Programming the MODES of the 8253.
2. Loading the count registers.
3. Reading the count values.

Read/Write Logic

The Read/Write Logic accepts inputs from the system bus and in turn generates control signals for overall device operation. It is enabled or disabled by CS so that no operation can occur to change the function unless the device has been selected by the system logic.

RD*(Read)

A “low” on this input informs the 8253 that the CPU is inputting the data in the form of a counter value.

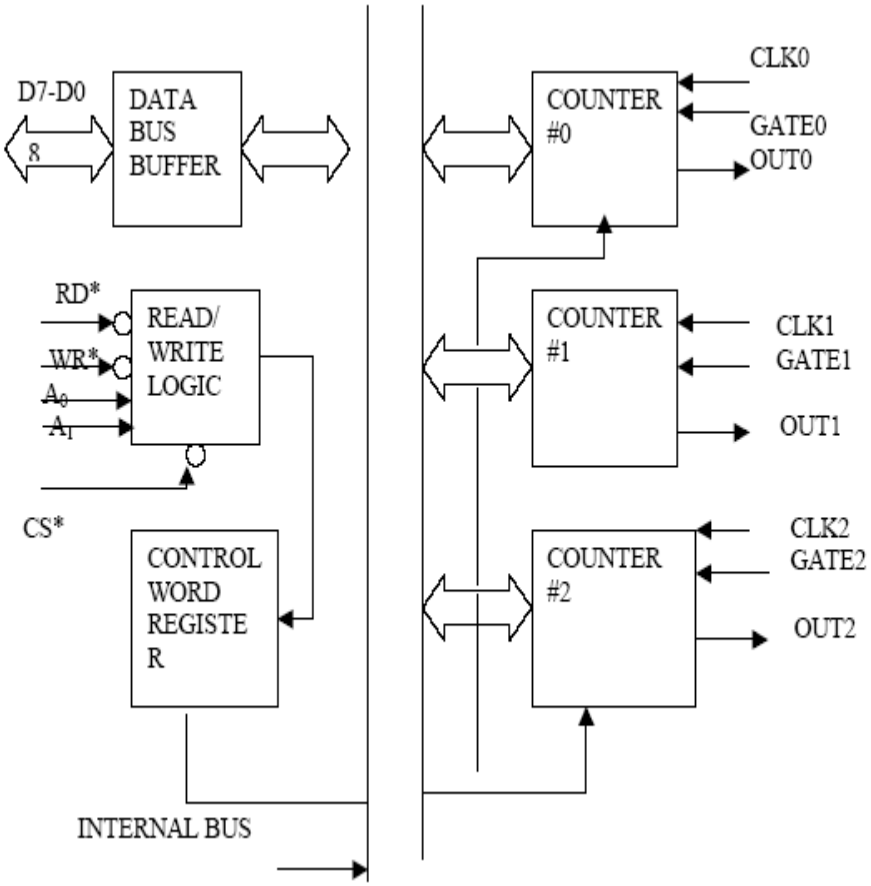
WR*(Write)

A “low” on this input informs the 8253 that the CPU is outputting the data in the form of mode information or loading counters

A0, A1

These inputs are normally connected to the address bus. Their function is to select one of the three counters to be operated on and to address the control word register for mode selection.

CS*(Chip Select)
A "low" on this input informs the 8253. No reading or writing will occur unless the device is selected. The CS*input has no effect upon the actual operation of the counters.



CS*	RD*	WR*	A1	A0	
0	1	0	0	0	Load Counter No.0
0	1	0	0	1	Load Counter No.1
0	1	0	1	0	Load Counter No.2
0	1	0	1	1	Write Mode Word
0	0	1	0	0	Read Counter No.0
0	0	1	0	1	Read Counter No.1
0	0	1	1	0	Read Counter No.2
0	0	1	1	1	No-operation 3 state
1	X	X	X	X	Disable 3 state
0	1	1	X	X	No-operation 3 state

Control Word Register

The control word register is selected when A0, A1 are 11. It then accepts information from the data bus buffer and stores it in a register. The information stored in this register controls the operational MODE of each counter, selection of binary or BCD counting and the loading of each count register.

The Control Word Register can only be written into; no read operation of its contents is available.

Counter #0, counter#1, counter#2

These three function blacks are identical in operation so only a single counter will be described. Each Counter consists of a single ,16, pre-settable , DOWN counter. The counter can operate in either binary or BCD and its input, gate and output are configured by the selection of MODES stored in the Control Word Register.

The counters are fully independent and each can have separate Mode configuration and counting operation, binary or BCD. Also ,there are special features in the control word that handle the loading of the count value so that software overhead can be minimized for these functions .

The reading of the contents of each counter is available to the programmer with simple READ operations for event counting applications and special commands and logic are included in the 8253 so that the contents of each counter can read "on the fly" without having to inhibit the clock input.

8253 SYSTEM INTERFACE

The 8253 is a component of the Intel ™ microcomputer systems and interfaces in the same manner as all other peripherals of the family. It is treated by the system software as an array of peripheral I/O ports ; three are counters and the fourth is a control register for MODE programming.

Basically, the select inputs A0, A1 connect to the A0,A1 address bus signals of the CPU. The CS* can be derived directly from the address bus using a linear select method. Or it can be connected to the output of a decoder, such as an Intel 8205 for larger systems.

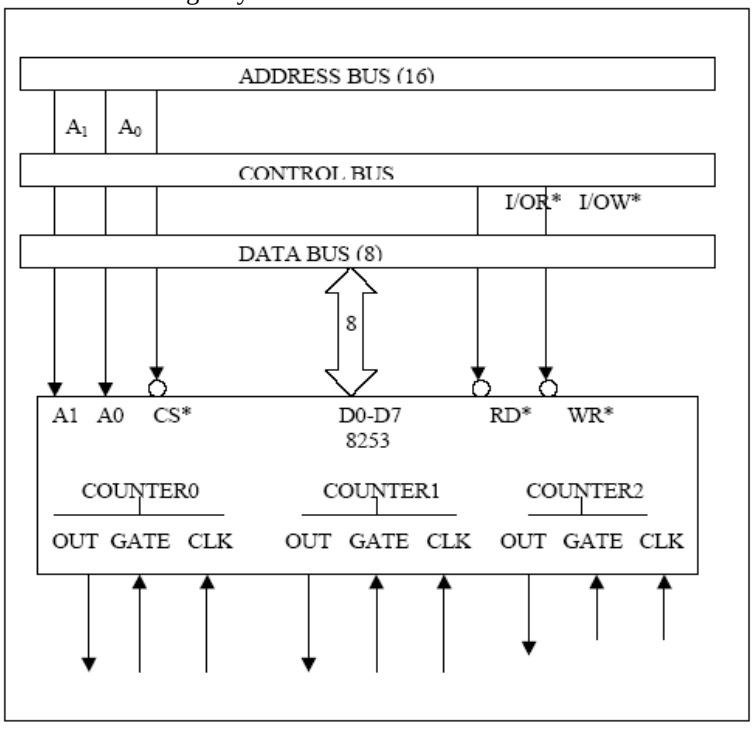


Figure 4: Block Diagram Showing Control Word Register and Counter Functions.

OPERATIONAL DESCRIPTION

General

The complete functional definition of the 8253 is programmed by the systems software. A set of control words must be sent out by the CPU to initialize each counter of the 8253 with the desired MODE and quantity information. Prior to initialize, the MODE, count, and output of all counters is undefined.
These control words program the MODE, Loading sequence and selection of binary or BCD counting.
Once programmed, the 8253 is ready to perform whatever timing tasks it is assigned to accomplish.
The actual counting operation of each counter is completely independent and additional logic is provided on-chip so that the usual problems associated with efficient monitoring and management of external, asynchronous events or rates to the microcomputer system have been eliminated.

Programming the 8253

All of the MODES for each counter are programmed by the system software by simple I/O operations.
Each counter of the 8253 is individually programmed by writing a control word in to the control word register. (A0 A1=11).

Control Word Format

D7	D6	D5	D4	D3	D2	D1	D0
SC1	SC0	RL1	RL0	M2	M1	M0	BCD

Definition of Control

SC –Select Counter:

SC1	**SC0**	
0	0	Select Counter 0
0	1	Select Counter 1
1	0	Select Counter 2
1	1	Illegal

RL-Read/Load:

RL1	**RL0**	
0	0	Counter latching operation (see READ/WRITE procedure section)
1	0	Read/Load most significant byte only.
0	1	Read/Load least significant byte only.
1	1	Read/Load least significant byte first, then most significant byte.

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

BCD:

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

Counter Loading

The count register is not loaded until the count value is written (one or two bytes, depending on the mode selected by the RL bits), followed by a rising edge and a falling edge of the clock. Any read of the counter prior to that falling clock edge may yield invalid data.

Mode Definition

MODE 0: Interrupt on Terminal count. The output will be initially low after the mode set operation. After the count is loaded into the selected count register, the output will remain low and the counter will count. When the terminal count is reached the output will go high and remain high until the selected count register is reloaded with the mode or a new count is loaded. The counter continues to decrement after terminal count has been reached.

Rewriting a counter register during counting result in the following

1. Write 1st byte stops the current counting.
2. Write 2nd byte start the new count.

MODE 1: Programmable One-Shot. The output will go low on the count following the rising edge of the gate input.

The output will go high on the terminal count. If a new count value is loaded while the output is low it will not affect the duration of the one –shot pulse until the succeeding trigger. The current count can be read at any time without affecting the one-shot pulse.

The one–shot is retriggerable, hence the output will remain low for the full count after any rising edge of the gate input.

MODE 2: Rate Generator. Divide by N counter. The output will be low for one period of the input clock. The period from the output pulse to the next equals the number of input counts in the count register. If the count register is reloaded between output pulses the present period will not be affected, but the subsequent period will reflect the new value.

The gate input, when low, will force the output high. When the gate input goes high, the counter will start from the initial count. Thus the gate input can be used to synchronize the counter
When this mode is set, the output will remain high until after the counter register is loaded. The output then can also synchronized by software.

Mode 3: Square Wave Rate Generator. Similar to MODE 2 except that the output will remain high until one half the count has been completed (for even numbers) and go low for the other half of the count. This is accomplished by decrementing the counter by two on the falling edge of each clock pulse. When the counter reaches terminal count , the state of the output is changed and the counter is reloaded with the full count and the whole process is repeated .

If the count is odd and the output is high, the first clock pulse (after the count is loaded) decrements the count by 1. Subsequent clock pulses decrement the clock by 2. After timeout, the output goes low and the full count

is reloaded. The first clock pulse (following the reload) decrements the counter by 3. Subsequent clock pulses decrement the count by 2 until the timeout. Then the whole process is repeated in this way, if the count is odd, the output will be high for (N+1)/2 counts and low for (N-1)/2 counts.

MODE 4:Software Triggered Strobe. After the mode is set , the output will be high. When the count is loaded. The counter will begin counting . On terminal count, the output will go low for one input clock period, and then will go high again.

If the count register is reloaded between output pulses, the present period will not be affected, but the subsequent period will reflect the new value. The count will be inhibited while the gate input is low. Reloading the counter register will restart counting beginning with new number.

MODE 5: Hardware Triggered strobe. The counter will start counting after the rising edge of the trigger input and will go low for one clock period when the terminal count is reached. The counter is retriggerable. The output will not go low until the full count after the rising edge of any trigger

Modes/Signal Status	**Low Or going low**	**Rising**	**High**
0	Disables counting		Enables counting
1		1.Initiates counting 2.Resets output after next clock	
2	1.Disables counting 2.Sets output immediately high	1.Reloads counter 2.Initiates counting	Enables counting
3	1.Disables counting 2.Sets output immediately high	Initiates counting	Enables counting
4	Disables counting		Enables counting
5		Initiates counting	

Figure 6. Gate Pin Operations Summary.

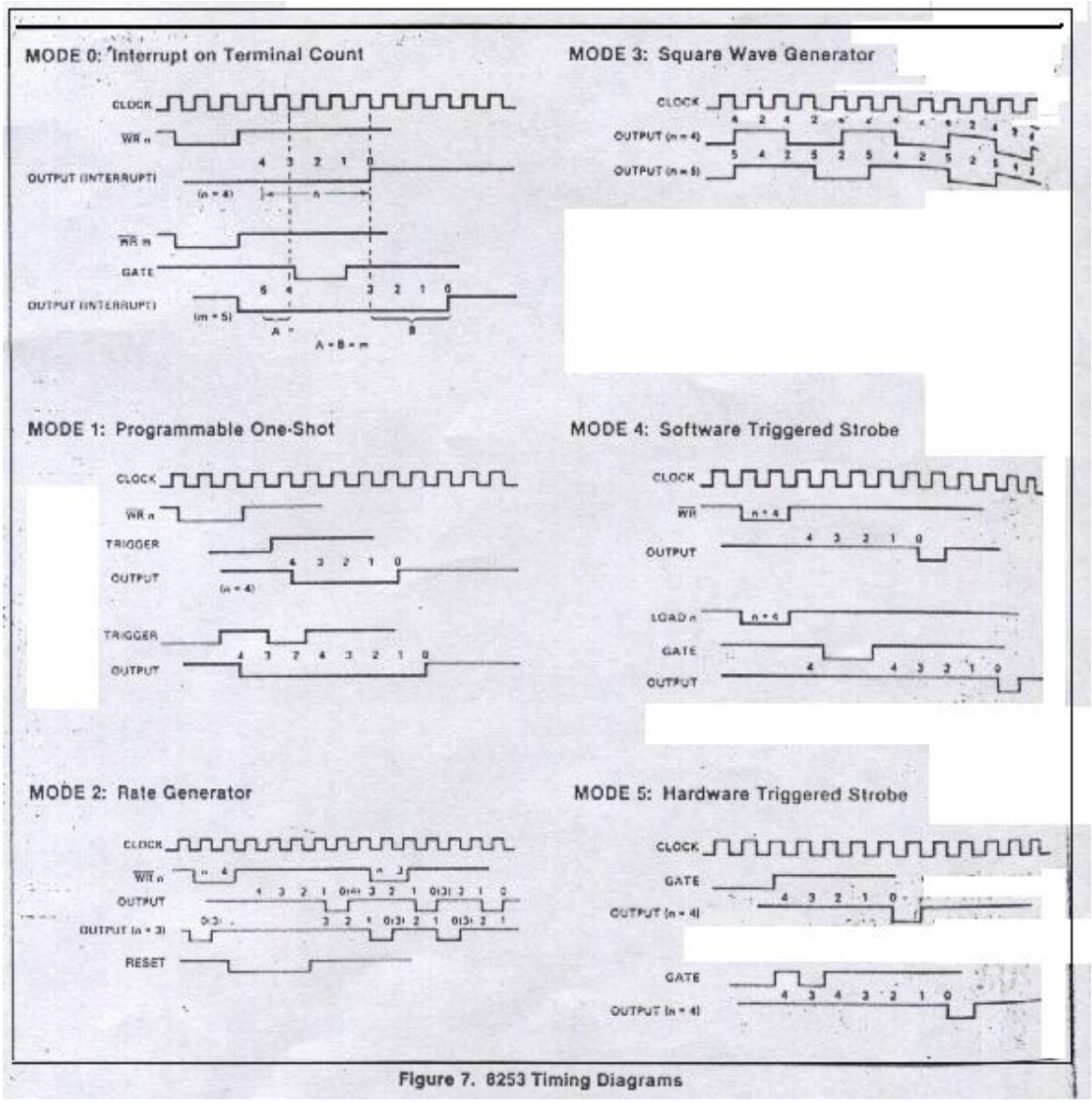


Figure 7. 8253 Timing Diagrams

8253 READ/WRITE PROCEDURE

Write Operations

The system software must program each counter of the 8253 with the mode and quantity desired. The programmer must write out to the 8253 a MODE control word and the programmed number of count register bytes (1 or 2) prior to actually using the selected counter.

The actual order of the programming is quite flexible. Writing out of the MODE control word can be in any sequence of counter section, e.g., counter#2 last. Each counter's MODE control word register has a separate address so that its loading is completely sequence independent. (SC0, SC1).

The loading of the count register with the actual count value, however must be done in exactly the sequence programmed in the MODE control word (RL0,RL1). This loading of the counter's count register is still sequence independent like the MODE control word loading, but when a selected count register is to be loaded it must be loaded with the number of bytes programmed in the MODE control word (RL0-RL1). The one or two bytes to be loaded in the count register do not have to follow the associated MODE control word. They can be programmed at any time following the MODE control word loading as long as the correct number of bytes is loaded in order.

All counters are down counters. Thus the value loaded in to the count register will actually be decremented. Loading all zeroes in to a count register will result in the maximum count (2^{16} for binary or 10^4 for BCD). In MODE 0 the new count will not restart until the load has been completed. It will accept one of two bytes depending on how the MODE control words (RL0-RL1) are programmed. Then proceed with the restart operation.

	MODE Control Word Counter n
LSB	Count Register byte Counter n
MSB	Count Register byte Counter n

Note: Format shown is a simple example of loading the 8253 and does not reply imply that it is the only format that can be used.

			A1	A0
No.1		MODE control Word Counter 0	1	1

No.2		MODE control Word Counter 1	1	1
No.3		MODE control Word Counter 2	1	1
No.4	LSB	Count Register Byte Counter 1	0	1
No.5	MSB	Count Register Byte Counter 1	0	1
No.6	LSB	Count Register Byte Counter 2	1	0
No.7	MSB	Count Register Byte Counter 2	1	0
No.8	LSB	Count Register Byte Counter 0	0	0
No.9	MSB	Count Register Byte Counter 0	0	0

Note: The exclusive addresses of each counter's count register make the task of programming the 8253 a very simple matter, and maximum effective use of the device will result if this feature is fully utilized.

Figure 9. Alternating Programming Formats.

Read operations

In most counter applications it becomes necessary to read the value of the count in progress and make a computational decision based on this quantity. Event counters are probably the most common application that uses this function. The 8253 contains logic that will allow the programmer to easily read the contents of any of three counters without disturbing the actual count in progress.

There are two methods that the programmer can use to read the value of the counters. The first method involves the use of simple I/O read operations of the selected counter. By controlling the A0, A1 inputs to the 8253 the programmer can select the counter to be read (remember that no read operation of the mode register is allowed. A0, A1-A11). The only requirement with this method is that in order to assure a stable count reading the actual operation of the selected counter must be inhibited either by controlling the Gate input or by external logic that inhibits the clock input. The contents of the counter selected will be available as follows.

First I/O Read contains the least significant byte (LSB).. Second I/O Read contains the most significant byte (MSB).

Due to the internal logic of the 8253 it is absolutely necessary to complete the entire reading procedure. If two bytes are programmed to be read then two bytes must be read before any loading WR commands can be sent to the same counter.

Read Operation Chart

A1	**A0**	**RD**	
0	0	0	Read Counter No.0
0	1	0	Read Counter No.1
1	0	0	Read Counter No.2
1	1	0	Illegal

Reading While Counting

The order for the programmer to read the contents of any counter without effecting or disturbing the counting operation the 8253 has special internal logic that can be accessed using simple WR commands to the MODE register. Basically in the programmer wishes to read the contents of a selected counter " on the fly" he loads the MODE register with a special code which lathes

MODE Register for Latching count

A0,A1=11

D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
SC1	SC0	0	0	X	X	X	X

SC1,SC0-Specify counter to be latched.

D5,D4-D0 designates counter latching operation.

X-don't care

The same limitation applies to this mode of reading the counter as the previous method. That is, it is mandatory to complete the entire read operation as programmed. This command has no effect on the counter's mode.

4.0 Demonstration programs for 8085 Series kits.
Sample programs for MPS 85-3 and ESA 85-2 trainer
1. Program to display "WELCOME TO ESA 8251 STUDY CARD" for 9600 baud by initializing 8251.Execute the program from 8000H.

```
                        CMD53   EQU     83H
                        CMD51   EQU     91H
                        DAT51   EQU     90H
```

ADDRESS	OPCODE	LABLE	MNOMONIC	COMMENTS
			ORG 8000H	
8000	11 0A 00		LXI D,000AH	;TIMER 0 for ;9600 BAUD
8003	3E 36		MVI A,36H	;TIMER 0 IN ;MODE 3
8005	D3 83		OUT CMD53	
8007	7B		MOV A,E	;LOAD LSB VALUE
8008	D3 80		OUT 80H	
800A	7A		MOV A,D	;LOAD MSB VALUE
800B	D3 80		OUT 80H	
800D	AF		XRA A	;DUMMY MODE
800E	D3 91		OUT CMD51	;WRITE DUMMY ;word
8010	D3 91		OUT CMD51	;IN MODE reg
8012	D3 91		OUT CMD51	
8014	D3 91		OUT CMD51	
8016	3E 40		MVI A,40H	;RESET 8251
8118	D3 91		OUT CMD51	
801A	3E CE		MVI A,0CEH	;SET 8251 FOR
801C	D3 91		OUT CMD51	;ASYNCHRONOUS 16 ;16X baud. ;2 STOP BITS,8 ;data bits, ;No parity
801E	3E 27		MVI A,27H	;WRITE COMMAND ;Word
8020	D3 91		OUT CMD51	
8022	21 00 90		LXI H,9000H	;MEMORY TO STORE ;the character
8025	06 33		MVI B,33H	;CHARACTER
8027	DB 91	STATUS:	IN CMD51	;GET USART ;status
8029	E6 81		ANI 81H	;RECEIVER READY
802B	FE 81		CPI 81K	;NO,WAIT
802D	C2 27 80		JNZ STATUS	;GET CHARACTER ;FROM USART
8030	7E		MOV A,M	

```
8031       D3 90                OUT DAT51
8033       23                   INX H
8034       05                   DCR B
8035       C2 27 80             JNZ STATUS

9000       0A 0A 0A 0A          ORG 9000H
9004       0A 0A 0A 20  TABLE:  WELCOME TO ESA
9008       20 20 20 20          8251 STUDY CARD
900C       20 20 20 20
9010       20 20 20 57
9014       45 4C 43 4F
9018       4D 45 20 54
901C       4F 20 45 53
9020       41 20 38 32
9024       35 31 20 53
9028       54 55 54 59
902C       20 43 41 52
9030       44 2E 0D OA
```

****

Sample programs for MPS 85-3 and ESA 85-2 trainer
2.Program to receive characters from the USART and display it on console as well as stored it in memory from 8500H.The program is in a continuous loop
Press ESC to come out of the loop.

```
CMD53   EQU     83H
CMD51   EQU     91H
DAT51   EQU     90H
```

ADDRESS	OPCODE	LABLE	MNEMONIC	COMMENTS
			ORG 8000H	
8000	11 0A 00		LXI D,000AH	;TIMER 0 for ;9600 BAUD
8003	3E 36		MVI A,36H	;TIMER0 IN ;MODE 3
8005	D3 83		OUT CMD53	
8007	7B		MOV A,E	;LOAD LSB VALUE
8008	D3 80		OUT 80H	
800A	7A		MOV A,D	;LOAD MSB VALUE
800B	D3 80		OUT 80H	
800D	AF		XRA A	;DUMMY MODE
800E	D3 91		OUT CMD51	;WRITE DUMMY ;WORD
8010	D3 91		OUT CMD51	;IN MODE ;REGISTER
8012	D3 91		OUT CMD51	
8014	D3 91		OUT CMD51	

```
8016       3E 40                MVI A,40H       ;RESET 8251
8018       D3 91                OUT CMD51
801A       3E CE                MVI A,0CEH      ;SET 8251 FOR
801C       D3 91                OUT CMD51       ;ASYNCHRONOUS
                                                ;16XBAUD,
                                                ;2 STOP BITS,8
                                                ;DATA
                                                ;BITS,NO PARITY
801E       3E 27                MVI A,27H       ;WRITE COMMAND
                                                ;WORD
8020       D3 91                OUT CMD51
8022       21 00 85             LXI H,8500H     ;MEMORY TO STORE
                                                ;THE
8025       CD 37 80   BACK:     CALL GETCH      ;CHARACTER TO
                                                ;MEMORY
8028       79                   MOV A,C
8029       FE 1B                CPI 27
802B       CA 36 80             JZ DOWN
802E       CD 42 60             CALL SOUTPT
8031       71                   MOV M,C
8032       23                   INX H
8C33       C3 25 80             JMP BACK
8036       EF         DOWN:     RST 5
8037       DB 91      GETCH:    IN CMD51        ;GET USART
                                                ;STATUS
8039       E6 02                ANI 02H         ;RECEIVER READY
803B       CA 37 80             JZ GETCH        ;NO,WAIT
803E       DB 90                IN DAT51        ;GET CHARACTER
8040       4F                   MOV C,A         ;FROM USART
8041       C9                   RET
8042       DB 91      SOUTPT:   IN CMD51
8044       E6 81                ANI 81H
8046       FE 81                CPI 81H
8048       C2 42 80             JNZ SOUTPT
804B       79                   MOV A,C
804C       D3 90                OUT DAT51
804E       C9                   RET

*************************************************************
```

Sample programs for MPS 85-3 and ESA 85-2 trainer
3. Initialize Timer 1 and display the count on Data field of the trainer display. Execute the program from 8000H.The program is in a continuous loop, press RESET key to come out of the loop.

```
CMD53    EQU     83H
CMD51    EQU     91H
```

```
                DAT51    EQU     90H
```

ADDRESS	OPCODE	LABLE	MNEMONIC	COMMENTS
			ORG 8000H	
8000	21 FF FF		LX1 H,0FFFFH	;INITIALISE
				;TIMER 1
8003	3E 76		MVI A,76H	;FOR MODE 3
8005	D3 83		OUT CMD53	
8007	7D		MOV A,L	;LSB OF TIMER 1
8008	D3 81		OUT 81H	
800A	7C		MOV A,H	;MSB OF TIMER 2
800B	D3 81		OUT 81H	
800D	3E 96		MVI A,96H	;LODE MODE WORD
800F	D3 83		OUT CMD53	
8011	3E FF		MVI A,0FFH	
8013	D3 82	ODT:	OUT 82H	
8015	3E 86		MVI A,86H	;LATCH COMMAND
				;WORD
8017	D3 83		OUT CMD53	
8019	DB 82		IN 82H	
801B	32 Fl 8F		STA 8FF1H	
801E	FE 80		CPI 80H	
8020	CA 3F 80		JZ NDT	
8023	06 00		MVI B,00H	
8025	CD 4C 04		CALL 044C	
8028	CD 2E 80		CALL DLY	
802B	C3 15 80		JMP ODT+2	
802E	16 FF	DLY:	MVI D,0FFH	
8030	1E 33	LP1:	MVI E,33H	
8032	1D	LP:	DCR E	
8033	00		NOP	
8034	00		NOP	
8035	00		NOP	
8036	00		NOP	
8037	C2 32 80		JNZ LP	
803A	15		DCR D	
803B	C2 30 80		JNZ LP1	
803E	C9		RET	
803F	3E 70	NDT:	MVI A,70H	
8041	C3 13 80		JMP ODT	

Sample programs for MPS 85-3 and ESA 85-2 trainer

4. Program to display "DEMO PROGRAM FOR AYSNCHRONOUS COMMUNICATION IN INTERRUPT MODE" by using interrupt driven. Execute the program from 8000H.

ADDRESS	OPCODE	LABLE	MNOMONIC	COMMENTS
			ORG 8000H	
8000	11 0A 00		LXI D,000AH	;TIMER 0 for
				;9600 baud
8003	3E 36		MVI A,36H	;TIMER 0 IN

```
                                                    ;MODE 3.
8005       D3 83                OUT CMD53
8007       7B                   MOV A,E          ;LOAD LSB VALUE
8008       D3 80                OUT 80H
800A       7A                   MOV A,D          ;LOAD MSB VALUE
800B       D3 80                OUT 80H
800D       AF                   XRA A            ;DUMMY MODE
800E       D3 91                OUT CMD51        ;WRITE DUMMY WORD
8010       D3 91                OUT CMD51        ;IN MODE REGISTER
8012       D3 91                OUT CMD51
8014       D3 91                OUT CMD51
8016       3E 40                MVI A,40H        ;RESET 8251
8018       D3 91                OUT CMD51
801A       3E CE                MVI A,0CEH       ;SET 8251 FOR
801C       D3 91                OUT CMD51        ;ASYNCHRONOUS
                                                 ;16XBAUD,
                                                 ;2 STOP BITS,8
                                                 ;DATA BITS
                                                 ;NO PARITY
801E       3E 27                MVI A,27H        ;WRITE COMMAND
                                                 ;WORD
8020       D3 91                OUT CMD51
8022       21 00 90             LXI H,9000H      ;MEMORY TO STORE
                                                 ;THE
8025       06 45                MVI B,45H        ;CHARACTER
8027       3E 0E                MVI A,0EH        ;ENABLE RST 5.5
8029       30                   SIM
802A       FB                   EI
802B       78             LOOP: MOV A,B
802C       F6 00                ORI 0
802E       C2 2B 80             JNZ LOOP
8031       EF                   RST 5
8032       F5         STATUS:   PUSH PSW
8033       7E                   MOV A,M
8034       D3 90                OUT DAT51
8036       23                   INX H
8037       05                   DCR B
8038       F1                   POP PSW
8039       FB                   EI
803A       C9                   RET

9000       0A 0A 20 20 20  TABLE:ORG 9000H
9005       44 45 4D 4F 20        DEMO PROGRAM FOR
900A       50 52 4F 47 52        ASYNCHRONOUS
900F       41 4D 20 46 4F        COMMUNICATION IN
9014       52 20 41 53 59        INTERUPT MODE
9019       4E 43 48 52 4F
901E       4E 4F 55 53 20
9023       43 4F 4D 4D 55
9028       4E 49 43 41 54
902D       49 4F 4E 20 49
9032       4E 20 49 4E 54
9037       45 52 52 55 50
```

```
903C       54 20 4D 4F 44
9041       45 2E 0D 0A 00
                              ORG 8FB3H
8FB3       C3 32 80           JMP STATUS
*************************************************************
```

5.0 Demonstration programs for 8051 Series kits.
EXAMPLE PROGRAMS FOR ESA 31/51 TRAINERS
1.Program to display "WELCOME TO ESA 8251 STUDY CARD" for 9600 baud by initializing 8251. Execute the Program at 8000H.

```
                    CONTROL REGISTER = F183
                    DATA PORT        = F190
                    COMMAND PORT     = F191
```

ADDRESS	OPCODE	LABLE	MNEMONIC	COMMENTS
			ORG 8000H	
8000	74 36		MOV A,#36H	;Timer0 for ;9600 baud
8002	90 F1 83		MOV DPTR,#0F183H	;in mode3
8005	F0		MOVX @DPTR,A	
8006	90 F1 80		MOV DPTR,#0F180H	
8009	74 0A		MOV A,0AH	
800B	F0		MOVX @DPTR,A	
800C	74 00		MOV A,#00H	
800E	F0		MOVX @DPTR,A	
800F	90 F1 91		MOV DPTR,#0F191H	;USART
8012	F0		MOVX @DPTR,A	
8013	F0		MOVX @DPTR,A	
8014	F0		MOVX @DPTR,A	
8015	F0		MOVX @DPTR,A	
8016	74 40		MOV A,#40H	;Reset 8251
8018	F0		MOVX @DPTR,A	
8019	74 CE		MOV A,#0CEH	
801B	F0		MOVX @DPTR,A	
801C	74 01		MOV A,#01H	
801E	F0		MOVX @DPTR,A	
801F	90 90 00		MOV DPTR,#9000H	
8022	79 00		MOV R1,#00H	
8024	C0 83	STATUS:	PUSH DPH	;Get USART ;Status
8026	C0 82		PUSH DPL	
8028	90 F1 91		MOV DPTR,#0F191H	
802B	E0		MOVX A,@DPTR	
802C	54 81		ANL A,#81H	
802E	D0 82		POP DPL	
8030	D0 83		POP DPH	
8032	B4 01 EF		CJNE A,#01H,STATUS	
8035	74 00		MOV A,#00H	
8037	93		MOVC A,@A+DPTR	
8038	B4 00 03		CJNE A,#00H,CONT	
803B	02 00 00		LJMP 0	

```
803E       C0 83        CONT:     PUSH DPH
8040       C0 82                  PUSH DPL
8042       90 F1 90               MOV DPTR,#0F190H
8045       F0                     MOVX @DPTR,A
8046       D0 82                  POP DPL
8048       D0 83                  POP DPH
804A       A3                     INC DPTR
804B       80 D7                  SJMP STATUS


                                  ORG 9000H
9000       0A 0A 0A 0A 0A      TABLE: DB 0AH,0AH,0AH,0AH,0AH
9005       0A 0A 0A                   DB 0AH,0AH,0AH
9008       20 20 20 20 20             DB 20H,20H,20H,20H,20H
900D       20 20 20                   DB 20H,20H,20H
9010       57 45 4C 43 4F             DB 'WELCOME TO ESA STUDY
                                            CARD',0DH,00H'
9015       4D 45 20 54 4F
9D1A       20 45 53 41 20
901F       53 54 55 44 59
9024       20 43 41 52 44
9029        0D 00
```

EXAMPLE PROGRAMS FOR ESA 31/51 TRAINERS

2.Program to receive characters from the USART and display it on Console as well as stored it in memory from 9000h. The program is in a continuous loop, press ESC to come out from the loop. Execute the Program at 8000H.

```
ADDRESS    OPCODE      LABLE        MNEMONIC              COMMENTS
                                    ORG 8000H
8000       74 36                    MOV A,#36H
8002       90 Fl 83                 MOV DPTR,#0F183H ;TIMER 0 CMD
8005       F0                       MOVX @DPTR,A
B006       90 Fl 80                 MOV DPTR,#0F180H
8009       74 0A                    MOV A,#0AH            ;TIMER 0DATA
800B       F0                       MOVX @DPTR,A
800C       74 00                    MOV A,#00H
800E       F0                       MOVX @DPTR,A
800F       90 Fl 91                 MOV DPTR,#0F191H      ;Initialize
                                                          ;USART
8012       F0                       MOVX @DPTR,A
8013       F0                       MOVX @DPTR,A
```

```
8014      F0                    MOVX @DPTR,A
8015      F0                    MOVX @DFTR,A
8016      74 40                 MOV A,#40H
8018      F0                    MOVX @DPTR,A
8019      74 CE                 MOV A,#CEH
801B      F0                    MOVX @DPTR,A
801C      74 25                 MOV A,#25H
801E      F0                    MOVX @DPTR,A
801F      90 90 00              MOV DPTR,#9000H ;Memory to
                                                ;store the
8022      C0 83                 PUSH DPH        ;Character
8024      C0 82                 PUSH DPL
8026      90 Fl 91   GETCH:     MOV DPTR,#0F191H
8029      E0                    MOVX A,@DPTR
802A      54 02                 ANL A,#02H
802C      60 F8                 JZ GETCH
802E      90 Fl 90              MOV DPTR,#0F190H
8031      E0                    MOVX A,@DPTR
8032      F5 F0                 MOV 0F0H,A
8034      B4 1B 03              CJNE A,#1BH,SOUTPT
8037      02 00 03              LJMP 3
803A      90 Fl 91   SOUTPT:    MOV DPTR,0F191H
803D      E0         STATUS:    MOVX A,@DPTR    ;Get USART
                                                ;status
803E      54 01                 ANL A,#0lH      ;Receiver
                                                ;ready
8040      B4 01 FA              CJNE A,#0lH,STATUS

8043      E5 F0                 MOV A,0F0H
8045      90 Fl 90              MOV DPTR,#0F190H
8048      F0                    MOVX @DPTR,A
8049      D0 82                 POP DPL
804B      D0 83                 POP DPH
804D      F0                    MOVX @DPTR,A
804E      A3 80                 INC DPTR
8050      D1 FE                 SJMP GETCH
```

EXAMPLE PROGRAMS FOR ESA 31/51 TRAINERS

3.Program to Display "DEMO PROGRAM FOR 110 BAUD". Execute the Program at 8000H.

```
CONTROL REGISTER = F183
DATA PORT        = F190
COMMAND PORT     = F191
```

ADDRESS	OPCODE	LABLE	MNEMONIC	COMMENTS
			ORG 8000H	
8000	74 36		MOV A,#36H	
8002	90 F1 83		MOV DPTR,#0F183H	
8005	F0		MOVX @DPTR,A	;Timer 0 in ;mode 3

```
8006       90 F1 80              MOV DPTR,#0F180H
8009       74 69                 MOV A,#69H
800B       F0                    MOVX @DPTR,A
800C       74 03                 MOV A,#03H
800E       F0                    MOVX @DPTR,A
800F       90 F1 91              MOV DPTR,#0F191H      ;Initialize
                                                       ;USART
8012       F0                    MOVX @DPTR,A
8013       F0                    MOVX @DPTR,A
8014       F0                    MOVX @DPTR,A
8015       F0                    MOVX @DPTR,A
8016       74 40                 MOV A,#40H            ;Reset 8251
8018       F0                    MOVX @DPTR,A
8019       74 CE                 MOV A,#0CEH
801B       F0                    MOVX @DPTR,A
801C       74 01                 MOV A,#01H
801E       F0                    MOVX @DPTR,A
801F       90 90 00              MOV DPTR,#9000H
8022       79 00                 MOV Rl,#00H
8024       C0 83       STATUS:   PUSH DPH
8026       C0 82                 PUSH DPL
8028       90 F1 91              MOV DPTR,#0F191H      ;Get USART
802B       E0                    MOVX A,@DPTR          ;status
802C       54 81                 ANL A,#81H

802E       D0 82                 POP DPL
8030       D0 83                 POP DPH
8032       B4 01 EF              CJNE A,#01H,STATUS
8035       74 00                 MOV A,#00H
8037       93                    MOVC A,@A+DPTR
8038       B4 00 03              CJNE A,#00H,CONT
803B       02 00 00              LJMP 0
803E       C0 83       CONT:     PUSH DPH
8040       C0 82                 PUSH DPL
8042       90 F1 90              MOV DPTR,#F190H
8045       F0                    MOVX @DPTR,A
8046       D0 82                 POP DPL
8048       D0 83                 POP DPH
804A       A3                    INC DPTR
804B       80 D7                 SJMP STATUS
                                 ORG 9000H
9000       0A 0A 0A 0A 0A  TABLE:     DB 0AH,0AH,0AH,0AH,0AH
9005       0A 0A 0A                   DB 0AH,0AH,0AH
9008       20 20 20 20 20             DB 20H,20H,20H,20H,20H
900D       20 20 20                   DB 20H,20H,20H

9010       44 45 4D 4F 20             DB 'DEMO PROGRAM FOR 110
                                           ;BAUD',0DH,00H
9015       50 52 4F 47 52
901A       41 4D 20 46 4F
901F       52 20 31 31 30
9024       20 42 41 55 44
9029       OD 00
```

EXAMPLE PROGRAMS FOR ESA 31/51 TRAINERS
4.Program to Display "DEMO PROGRAM FOR ASYNCHRONOUS COMMUNICATION IN INTERRUPT MODE" by using interrupt driven method.
Execute the Program at 8000H.

```
                    CONTROL REGISTER = F183
                    DATA PORT        = F190
                    COMMAND PORT     = F191
```

ADDRESS	OPCODE	LABLE	MNOMONIC	COMMENTS
			ORG 8000H	
8000	74 36		MOV A,#36H	
8002	90 F1 83		MOV DPTR,#F183H	;TIMER 0 CMD
8005	F0		MOVX @DPTR,A	
8006	90 F1 80		MOV DPTR,#F180H	;TIMER 0 ;DATA
8009	74 0A		MOV A,#0AH	
800B	F0		MOVX @DPTR,A	
800C	74 00		MOV A,#00H	
800E	F0		MOVX @DPTR,A	
800F	90 F1 91		MOV DPTR,#F191H	;Initialize
8012	F0		MOVX @DPTR,A	;USART
8013	F0		MOVX @DPTR,A	
8014	F0		MOVX @DPTR,A	
8015	F0		MOVX @DPTR,A	
8016	74 40		MOV A,#40H	
8018	F0		MOVX DPTR,A	
8019	74 CE		MOV A,#CEH	
801B	F0		MOVX @DPTR,A	
801C	74 27		MOV A,#27H	
801E	F0		MOVX @DPTR,A	
801F	90 81 50		MOV DPTR,#8150H	
8022	75 A8 85	EN:	MOV IE,#85H	;Enable INT1
			ORG FFF3H	
FFF3	02 90 00		LJMP STATUS	
			ORG 9000H	
9000	C0 D0	STATUS:	PUSH PSW	
9002	74 00	BACK:	MOV A,#00H	
9004	93		MOVC A,@A+DPTR	
9005	B4 00 03		CJNE A,#00H,NEXT	
9008	02 00 00		LJMP 0	
900B	C0 83	NEXT:	PUSH DPH	
900D	C0 82		PUSH DPL	
900F	90 F1 92		MOV DPTR,#F192H	
9012	F0		MOVX @DPTR,A	
9013	D0 82		POP DPL	
9015	D0 83		POP DPH	

```
9017       A3                    INC DPTR
9018       D0 D0                 POP PSW
901A       32                    RETI

                                 ORG 8150H
8150       0D 0A 0A 0A 0A              DB 0DH,0AH,0AH,0AH,0AH,0AH
8155       0A 0A 0A 0A                 DB 0AH,0AH,0AH
8159       20 20 20 20 20              DB 20H,20H,20H,20H,20H
815E       20 20 20                    DB 20H,20H,20H
8161       44 45 4D 4F 20              DB 'DEMO PROGRAM FOR
                                            ASYNCHRONOUS'
8166       50 52 4F 47 52
816B       41 4D 20 46 4F
8170       52 20 41 53 59
8175       4E 43 48 52 4F
817A       4E 4F 55 53 20


817F       43 4F 4D 4D 55              DB 'COMMUNICATION IN
                                            INTERRUPT MODE'
8184       4E 49 43 41 54
B189       49 4F 4E 20 49
818E       4E 20 49 4E 54
8193       45 52 52 55 50
8196       54 20 4D 4F 44
819D       45
819E       0D 00                       DB 0DH,00H
```

EXAMPLE PROGRAM FOR ESA 31 TRAINER

5a.Initialize Timer 1 and Display the count on Data field of the trainer Display. Execute the Program at 8000H. The program is in a continuous Loop, press RESET key to come out of the loop.

```
CONTROL REGISTER = F183
DATA PORT        = F190
COMMAND PORT     = F191
```

ADDRESS	OPCODE	LABLE	MNEMONIC	COMMENTS
			ORG 8000K	
8000	74 76		MOV A,#76H	;TIMER1 in ;mode3
8002	90 Fl 83		MOV DPTR,#F183H	
8005	F0		MOVX @DPTR,A	
8006	74 FF		MOV A,#FFH	
8008	90 F1 81		MOV DPTR,#F18lH	; TIMER 1 DATA
800B	F0		MOVX @DPTR,A	
800C	F0		MOVX @DPTR,A	
800D	74 96		MOV A,#96H	; Load mode ;word
800F	90 Fl 83		MOV DPTR,#F183H	
8012	F0		MOVX @DPTR,A	
8013	74 FF		MOV A,#FFH	; Data to ;counter2

```
8015       90 F1 82        ODT:  MOV DPTR,#F182H   ; Latch CMD
                                                  ;word
8018       F0                    MOVX @DPTR,A
8019       74 86           BACK: MOV A,#86H
801B       90 F1 83              MOV DPTR,#F183H   ; LATCH COMMAND
                                                   ;WORD
801E       F0                    MOVX @DPTR,A
801F       90 F1 82              MOV DPTR,F182H
8022       E0                    MOVX A,@DPTR
8023       B4 00 02              CJNE A,#00H,NEXT
8026       80 ED                 SJMP ODT
8028       F5 60           NEXT: MOV 60H,A
802A       75 F0 00              MOV 0F0H,#00H
802D       12 01 9B              LCALL 019BH

8030        79 FF                MOV R1,#FFH
8032       7A FF           X2:   MOV R2,#FFH
8034       DA FE           XI:   DJNZ R2,X1
8036       D9 FA                 DJNZ R1,X2
8038       80 DF                 SJMP BACK
```

EXAMPLE PROGRAM FOR51E TRAINER

5b. Initialize Timer 1 and display the count on Data field of the trainer display. Execute the program at 8000H.The program is in continuous loop, press RESET Key to come out of the loop.

```
                    CONTROL REGISTER    = F183
                    DATA PORT           = F190
                    COMMAND PORT        = F191
ADDRESS    OPCODE     LABLE        MNOMONIC              COMMENTS
                                ORG 8000H
8000       74 76                MOV A,#76H        ;Timer 1 in
                                                  ;mode 3
8002       90 F1 83             MOV DPTR,#F183H
8005       F0                   MOVX @DPTR,A
8006       74 FF                MOV A,#FFH
8008       90 F1 81             MOV DPTR,#F181H    ;Timer I data
800B       F0                   MOVX @DPTR,A
800C       F0                   MOVX @DPTR,A
800D       74 96                MOV A,#96H        ;Load mode word
800F       90 F1 83             MOV DPTR,#F183H
8012       F0                   MOVX @DPTR,A
8013       74 FF                MOV A,#FFH         ;Data to
                                                   ;counter 2
8015       90 F1 82        ODT: MOV DPTR,#F182H   ;Latch CMD word
8018       F0                   MOVX @DPTR,A
8019       74 86           BACK: MOV A,#86H
801B       90 F1 83             MOV DPTR,#F183H
801E       F0                   MOVX @DPTR,A
801F       90 F1 82        MOV DPTR,#F182H
```

```
8022       E0                    MOVX A,@DPTR
8023       B4 00 02              CJNE A,#00H,NEXT
8026       80 ED                 SJMP ODT
8028       F5 60           NEXT: MOV 71H,A
802A       75 F0 00              MOV 0F0H,#00H
802D       12 01 9B              LCALL 13D2H
8030       79 FF           MOV R1,#FFH
8032       7A FF           X2:   MOV R2,#FFH
8034       DA FE           XI:   DJN2 R2,X1
8036       D9 FA                 DJNZ R1,X2
8038       80 DF                 SJMP BACK
*****************************************************************
```

EXAMPLE PROGRAM FOR51E TRAINER

5c. Initialize Timer 1 and display the count on the console. Execute The program at 8000H.The program is in continuous loop. Press RESET Key to come out of the loop.

```
;CONTROL REGISTER    =F183H
;DATA PORT           =F190H
;COMMAND PORT        =F191H
```

ADDRESS	OPCODE	LABLE	MNOMONIC	COMMENTS
			ORG 8000H	
8000	74 76		MOV A,#76H	;Timer 1 in ;mode 3
8002	90 F1 83		MOV DPTR,#F183H	
8005	F0		MOVX @DPTR,A	
8006	74 FF		MOV A,#FFH	
8008	90 F1 81		MOV DPTR,#F181H	;Timer 1 data
800B	F0		MOVX @DPTR,A	
800C	F0		MOVX @DPTR,A	
800D	74 96		MOV A,#96H	;Load mode word
800F	90 F1 83		MOV DPTR,#F183H	
8012	F0		MOVX @DPTR,A	
8013	74 FF		MOV A,#FFH	;Data to ;counter 2
8015	90 F1 82	ODT:	MOV DPTR,#F182H	;Latch CMD word
8018	F0		MOVX @DPTR,A	
8019	74 86	BACK:	MOV A,#86H	
801B	90 F1 83		MOV DPTR,#F183H	
801E	F0		MOVX @DPTR,A	
801F	90 F1 82		MOV DPTR,#F182H	
8022	F0		MOVX A,@DPTR	
8023	B4 00 02		CJNE A,#00H,NEXT	
8026	80 ED		SJMP ODT	
8028	F5 71	NEXT:	MOV 71H,A	
802A	75 F0 00		MOV 0F0H,#00H	
802D	12 13 9E		LCALL 139EH	
8030	74 08		MOV A,#08H	
8032	12 11 AE		LCALL 11AEH	

```
8035        74 08                   MOV A,#08H
8037        12 11 AE                LCALL 11AEH
803A        79 FF                   MOV R1,#FFH
803C        7A FF             X2:   MOV R2,#FFH
803E        DA FE             X1:   DJNZ R2,X1
8040        D9 FA              DJNZ R1,X2
8042        80 D5                    SJMP BACK
                        END
```

6.0 Demonstration programs for 8086 series kits

EXAMPLE PROGRAMS FOR ESA 86/88-3 AND 86/88-2 TRAINERS

1.PROGRAM TO DISPLAY "WELCOME TO ESA STUDY CARD"FOR 9600 BAUD. EXECUTE THE PROGRAM FROM 2000H

CONTROL REGISTER 8253 = 0080H
DATA PORT 8251 = 0090H
COMMAND PORT 8251 = 0092H

.

ORG 2000H

ADDR	OPCODE	MNEMONIC	COMMENTS
0000:3000	B0 36	MOV AL,36	
0000:3002	BA 86 00	MOV DX,0086	
0000:3005	EE	OUT DX,AL	
0000:3006	BA 80 00	MOV DX,0080	;Timer 0 in mode 3
0000:3009	B0 0A	MOV AL,0A	
0000:300B	EE	OUT DX,AL	
0000:300C	B0 00	MOV AL,00	
0000:300E	EE	OUT DX,AL	
0000:300F	BC 00 30	MOV SP,3000	
0000:3012	BA 92 00	MOV DX,0092	;Initialize USART
0000:3015	EE	OUT DX,AL	
0000:3016	EE	OUT DX,AL	
0000:3017	EE	OUT DX,AL	
0000:3018	EE	OUT DX,AL	
0000:3019	E8 2E 00	CALL 304A	
0000:301C	B0 40	MOV AL,40	;Reset 8251
0000:301E	EE	OUT DX,AL	
0000:301F	E8 28 00	CALL 304A	
0000:3022	B0 CE	MOV AL,CE	
0000:3024	EE	OUT DX,AL	
0000:3025	E8 22 00	CALL 304A	
0000:3028	B0 27	MOV AL,27	
0000:302A	EE	OUT DX,AL	
0000:302B	E8 1C 00	CALL 304A	
0000:302E	BE 00 31	MOV SI,3100	
0000:3031	BA 92 00	MOV DX,0092	;Get USART status
0000:3034	EC	IN AL,DX	

```
0000:3035       24 81               AND   AL,81
0000:3037       3C 81               CMP   AL,81
0000:3039       75 F6               JNE   3031
0000:303B       8A 04               MOV   AL,[SI]
0000:303D       46                   INC   SI
0000:303E       3C 00               CMP   AL,00
0000:3040       74 07               JE    3049

0000:3042       BA 90 00            MOV   DX,0090
0000:3045       EE                  OUT   DX,AL
0000:3046       E9 E8 FF            JMP   3031
0000:3049       CC                  INT   03

                                    ORG 2100H
0000:2100       0A 0A               DB 0A,0A
0000:2102       0A 0A               DB 0A,0A
0000:2104       0A 0A               DB 0A,0A
0000:2106       0A 0A               DB 0A,0A
0000:2108       20 20               DB 20,20
0000:210A       20 20               DB 20,20
0000:210C       20 20               DB 20,20
0000:210E       20 20               DB 20,20
0000:2110       57 45 4C 43 4F 4D   ASC'WELCOME TO ESA STUDY CARD'
0000:2116       45 20 54 4F 20 45
0000:211C       53 41 20 53 54 55
0000:2122       44 59 20 43 41 52
0000:2128       44 00
```

2.PROGRAM TO RECEIVE CHARACTERS FROM THE USART AND DISPLAY IT ON CONSOLE.PROGRAM EXECUTED FROM 2000H

CONTROL REGISTER 8253 = 0080H
DATA PORT 8251 = 0090H
COMMAND PORT 8251 = 0092H

.

ORG 2000H

ADDR	OPCODE	MNEMONIC	COMMENTS
0000:2000	B0 36	MOV AL,36	
0000:2002	BA 86 00	MOV DX,0086	;Timer 0 in mode 0
0000:2005	EE	OUT DX,AL	
0000:2006	BA 80 00	MOV DX,0080	
0000:2009	B0 0A	MOV AL,0A	;Timer 0 DATA
0000:200B	EE	OUT DX,AL	
0000:200C	B0 00	MOV AL,00	
0000:200E	EE	OUT DX,AL	
0000:200F	BC 00 30	MOV SP,3000	
0000:2012	BA 92 00	MOV DX,0092	;Initialize USART
0000:2015	EE	OUT DX,AL	
0000:2016	EE	OUT DX,AL	

```
0000:2017    EE          OUT   DX,AL
0000:2018    EE          OUT   DX,AL
0000:2019    E8 43 00    CALL  205F
0000:201C    B0 40       MOV   AL,40        ;Reset 8251
0000:201E    EE          OUT   DX,AL
0000:201F    E8 3D 00    CALL  205F

0000:2022    B0 CE       MOV   AL,CE
0000:2024    EE          OUT   DX,AL
0000:2025    E8 37 00    CALL  205F
0000:2028    B0 27       MOV   AL,27


0000:202A    EE          OUT   DX,AL
0000:202B    E8 31 00    CALL  205F
0000:202E    BE 00 21    MOV   SI,2100
0000:2031    BA 92 00    MOV   DX,0092
0000:2034    EC          IN    AL,DX        ;Get USART status
0000:2035    24 02       AND   AL,02        ;Receiver Ready
0000:2037    74 F8       JE    2031
0000:2039    BA 90 00    MOV   DX,0090      ;Get character from
0000:203C    EC          IN    AL,DX        ;USART
0000:203D    3C 1B       CMP   AL,1B
0000:203F    8A D8       MOV   BL,AL
0000:2041    74 1B       JE    205E
0000:2043    BA 92 00    MOV   DX,0092
0000:2046    EC          IN    AL,DX
0000:2047    24 81       AND   AL,81
0000:2049    3C 81       CMP   AL,81
0000:204B    75 F6       JNE   2043
0000:204D    8A C3       MOV   AL,BL
0000:204F    BA 90 00    MOV   DX,0090
0000:2052    EE          OUT   DX,AL
0000:2052    EE          OUT   DX,AL
0000:2053    88 04       MOV   [SI],AL
0000:2055    46          INC   SI
0000:2056    E9 D8 FF    JMP   2031
0000:2059    EE          OUT   DX,AL
0000:205A    46          INC   SI
0000:205B    E9 E5 FF    JMP   2043
0000:205E    CC          INT   03
0000:205F    B9 02 00    MOV   CX,0002
0000:2062    E2 FE       LOOP  2062
0000:2064    C3          RET
```

3.PROGRAM TO DISPLAY "DEMO PROGRAM FOR 110 BAUD".EXECUTE PROGRAM FROM 2000H.

CONTROL REGISTER 8253 = 0080H
DATA PORT 8253 = 0090H
COMMAND PORT 8253 = 0092H

.

```
                        ORG  2000H
ADDR        OPCODE              MNEMONIC            COMMENTS

0000:2000   B0 36                       MOV   AL,36
0000:2002   BA 86 00                    MOV   DX,0086       ;Timer0 in mode 3
0000:2005   EE                          OUT   DX,AL
0000:2006   BA 80 00                    MOV   DX,0080
0000:2009   B8 69 03                    MOV   AX,0369
0000:200C   EE                          OUT   DX,AL
0000:200D   8A C4                       MOV   AL,AH
0000:200F   EE                          OUT   DX,AL
0000:2010   B0 00                       MOV   AL,00
0000:2012   BA 92 00                    MOV   DX,0092       ;Initialization USART
0000:2015   EE                          OUT   DX,AL
0000:2016   EE                          OUT   DX,AL
0000:2017   EE                          OUT   DX,AL
0000:2018   EE                          OUT   DX,AL
0000:2019   B0 40                       MOV   AL,40         ;Reset 8251
0000:201B   EE                          OUT   DX,AL
0000:201C   B0 CE                       MOV   AL,CE
0000:201E   EE                          OUT   DX,AL
0000:201F   B0 27                       MOV   AL,27
0000:2021   EE                          OUT   DX,AL
0000:2022   BE 00 21                    MOV   SI,2100
0000:2025   BA 92 00        STATUS:     MOV   DX,0092       ;Get USART status
0000:2028   EC                          IN    AL,DX
0000:2029   24 81                       AND   AL,81
0000:202B   3C 81                       CMP   AL,81
0000:202D   75 F6                       JNE   2025
0000:202F   8A 04                       MOV   AL,[SI]
0000:2031   3C 00                       CMP   AL,00
0000:2033   74 08                       JE    203D
0000:2035   BA 90 00                    MOV   DX,0090
0000:2038   EE                          OUT   DX,AL
0000:2039   46                          INC   SI
0000:203A   EB E9                       JMP   2025
0000:203C   CC              OVER:       INT   03

0000:2100                               ORG 2100
0000:2100   0A 0A                       DB 0A,0A
0000:2102   0A 0A                       DB 0A,0A
0000:2104   0A 0A                       DB 0A,0A
0000:2106   0A 0A                       DB 0A,0A
0000:2108   20 20                       DB 20,20
0000:210A   20 20                       DB 20,20
0000:210C   20 20                       DB 20,20
0000:210E   20 20                       DB 20,20
0000:2110   44 45 4D 4F 20 50           ASC 'DEMO PROGRAM FOR 110 BAUD'
0000:2116   52 4F 47 52 41 4D
0000:211C   20 46 4F 52 20 31
0000:2122   31 30 20 42 41 55
0000:2128   44
0000:2129   00                          DB 00
```

4.PROGRAM TO INITIALIZE TIMER1 AND DISPLAY THE COUNT ON THE SERIAL MODE.EXECUTE THE PROGRAM FROM 2000H.THE PROGRAM IS IN CONTINUOUS LOOP, PRESS RESET KEY TO COME OUT OF THE LOOP.

CONTROL REGISTER 8253 = 0080H
DATA PORT 82153 = 0090H
COMMAND PORT 8251 = 0092H

ORG 2000H

ADDR	OPCODE		MNEMONIC	COMMENTS
0000:2000	B0 76		MOV AL,76	;Timer 1 CMD
0000:2002	BA 86 00		MOV DX,0086	
0000:2005	EE		OUT DX,AL	
0000:2006	B0 FF		MOV AL,FF	
0000:2008	BA 82 00		MOV DX,0082	;Timer 1 DATA
0000:200B	EE		OUT DX,AL	
0000:200C	EE		OUT DX,AL	
0000:200D	B0 96		MOV AL,96	;Timer 2 CMD
0000:200F	BA 86 00		MOV DX,0086	
0000:2012	EE		OUT DX,AL	
0000:2013	B0 FF		MOV AL,FF	
0000:2015	BA 84 00	ODT:	MOV DX,0084	;Latch command word
0000:2018	EE		OUT DX,AL	
0000:2019	B8 00 21		MOV AX,2100	
0000:201C	9A 31 00 00 FB		CALLS FB00:0031	
0000:2021	9A 13 00 00 FB		CALLS FB00:0013	
0000:2026	B0 86	BACK:	MOV AL,86	
0000:2028	BA 86 00		MOV DX,0086	
0000:202B	EE		OUT DX,AL	
0000:202C	BA 84 00		MOV DX,0084	
0000:202F	EC		IN AL,DX	
0000:2030	3C 00		CMP AL,00	
0000:2032	74 E1		JE ODT	
0000:2034	B4 00		MOV AH,00	
0000:2036	9A 52 00 00 FB		CALLS FB00:0052	
0000:203B	B9 FF FF		MOV CX,FFFF	
0000:203E	E2 FE		LOOP 203E	
0000:2040	B0 08		MOV AL,08	
0000:2042	9A 00 00 00 FB		CALLS FB00:0000	
0000:2047	9A 00 00 00 FB		CALLS FB00:0000	
0000:204C	E9 D7 FF		JMP BACK	
0000:2100			ORG 2100	
0000:2100	43 4F 55 4E 54 20		ASC 'COUNT VALUE:'	
0000:2106	56 41 4C 55 45 3A			
0000:210C	20			

```
0000:210D       00                          DB 00
```

5.PROGRAM TO DISPLAY "DEMO PROGRAM FOR ASYNCHRONOUS COMMUNICATION IN INTERRUPT MODE"BY USING INTERRUPT METHOD.EXECUTE PROGRAM FROM 2000H.

CONTROL REGISTER 8253 = 0080H
DATA PORT 8251 = 0090H
COMMAND PORT 8251 = 0092H

.

ORG 2000H

```
ADDR          OPCODE              MNEMONIC          COMMENTS
0000:2000     B8 00 00                MOV   AX,0000       ;Timer 0 in mode 3
0000:2003     8E C8                   MOV   CS,AX
0000:2005     8E C0                   MOV   ES,AX
0000:2007     BC 00 30                MOV   SP,3000
0000:200A     BE 50 21                MOV   SI,2150
0000:200D     26                INIT: ES
0000:200E     C7 06 24 01 00 21       MOVW  @0124,2100
0000:2014     26                      ES
0000:2015     C7 06 26 01 00 00       MOVW  @0126,0000
0000:201B     BA F4 FF                MOV   DX,FFF4
0000:201E     B0 13                   MOV   AL,13
0000:2020     EE                      OUT   DX,AL
0000:2021     BA F6 FF                MOV   DX,FFF6
0000:2024     B0 48                   MOV   AL,48
0000:2026     EE                      OUT   DX,AL
0000:2027     B0 03                   MOV   AL,03
0000:2029     EE                       OUT   DX,AL
0000:202A     B0 FD                   MOV   AL,FD
0000:202C     EE                      OUT   DX,AL
0000:202D     FB                      STI
0000:202E     B0 36                   MOV   AL,36
0000:2030     BA 86 00                MOV   DX,0086       ;Timer 0 cmd
0000:2033     EE                      OUT   DX,AL
0000:2034     BA 80 00                MOV   DX,0080       ;Timer 0 data
0000:2037     B0 0A                   MOV   AL,0A
0000:2039     EE                      OUT   DX,AL
0000:203A     B0 00                   MOV   AL,00
0000:203C     EE                      OUT   DX,AL
0000:203D     BA 92 00                MOV   DX,0092       ;Initialization USART
0000:2040     EE                      OUT   DX,AL
0000:2041     EE                      OUT   DX,AL
0000:2042     EE                       OUT   DX,AL
0000:2043     EE                       OUT   DX,AL
0000:2044     E8 1D 00                CALL  2064
0000:2047     B0 40                   MOV   AL,40         ;Reset 8251
0000:2049     EE                      OUT   DX,AL
0000:204A     E8 17 00                CALL  2064
```

```
0000:204D    B0 CE                      MOV   AL,CE
0000:204F    EE                         OUT   DX,AL
0000:2050    E8 11 00                   CALL  2064

0000:2053    B0 27                      MOV   AL,27
0000:2055    EE                         OUT   DX,AL
0000:2056    8A 04                BACK: MOV   AL,[SI]
0000:2058    3C 00                      CMP   AL,00
0000:205A    75 FA                      JNE   BACK
0000:205C    BA 92 00                   MOV   DX,0092          ;Get USART status
0000:205F    EE                         OUT   DX,AL
0000:2060    EE                         OUT   DX,AL
0000:2061    EE                         OUT   DX,AL
0000:2062    EE                         OUT   DX,AL
0000:2063    CC                         INT   03
0000:2064    B9 02 00             DLY:  MOV   CX,0002
0000:2067    E2 FE                      LOOP  2067
0000:2069    C3                         RET

0000:2100                               ORG 2100
0000:2100    9C                 STATUS: PUSHF
0000:2101    8A 04                      MOV   AL,[SI]
0000:2103    46                         INC   SI
0000:2104    BA 90 00                   MOV   DX,0090
0000:2107    EE                         OUT   DX,AL
0000:2108    9D                         POPF
0000:2109    FB                         STI
0000:210A    CF                  OVER:  IRET

0000:2150                               ORG 2150
0000:2150    0D 0A                      DB 0D,0A
0000:2152    0A 0A                      DB 0A,0A
0000:2154    0A 0A                      DB 0A,0A
0000:2156    0A 0A                      DB 0A,0A
0000:2158    20 20                      DB 20,20
0000:215A    20 20                      DB 20,20
0000:215C    20 20                      DB 20,20
0000:215E    20 20                      DB 20,20
0000:2160    44 45 4D 4F 20 50          ASC 'DEMO PROGRAM FOR ASYNCHRONOUS'
0000:2166    52 4F 47 52 41 4D
0000:216C    20 46 4F 52 20 41
0000:2172    53 59 4E 43 48 52
0000:2178    4F 4E 4F 55 53 20
0000:217E    43 4A 4D 4D 55 4E          ASC 'COMMUNICATION IN INTERRUPT MODE'
0000:2184    49 43 41 54 49 4F
0000:218A    4E 20 49 4E 20 49
0000:2190    4E 54 45 52 52 55
0000:2196    50 54 20 4D 4F 44
0000:219C    45
0000:219D    00 DB 00
```

.**********

DEMONSTRATION EXAMPLES FOR 86E Trainer

8251 & 8253 REGISTER ADDRESSES

The addresses for the 8253 registers on this card for use with ESA 86/88E Trainer are as follows:

Timer 0	-	FFC0H
Timer 1	-	FFC2H
Timer 2	-	FFC4H
Command Register	-	FFC6H

The addresses for the 8251 registers on this card for use with ESA 86/88E Trainer are as follows:

Command/Status Register	-	FFCAH
Data Register	-	FFC8H

Example 1. This program initializes the 8251 for 9600 baud and displays the message **'WELCOME TO ESA 8251/53 STUDY CARD'** on the console. Enter and execute the program from 0:2000H location

```
ADDRESS     OP-CODES    LABELS     MNEMONICS        COMMENTS
0000:2000                   M53   EQU   0FFC6
0000:2000                   TM0   EQU   0FFC0
0000:2000                   M51   EQU   0FFCA
0000:2000                   V51   EQU   0FFC8
0000:2000   B0 36               MOVB  AL,36      ;Initialize
                                                 ;TIMER 0
0000:2002   BA C6 FF            MOVW  DX,M53     ;for Mode 3
                                                 ;operation
0000:2005   EE                  OUTB  DX,AL
0000:2006   BA C0 FF            MOVW  DX,TMO
0000:2009   B0 0A               MOVB  AL,0A
0000:200B   EE                  OUTB  DX,AL      ;Load TIMER 0
                                                 ;count
0000:200C   B0 00               MOVB  AL,00      ;for 9600 baud
0000:200E   EE                  OUTB  DX,AL
0000:200F   BC 00 30            MOVW  SP,3000
0000:2012   BA CA FF            MOVW  DX,M51
0000:2015   EE                  OUTB  DX,AL      ;Reset 8251

0000:2016   EE                  OUTB  DX,AL
0000:2017   EE                  OUTB  DX,AL
0000:2018   EE                  OUTB  DX,AL

0000:2019   E8  2E 00           CALL  DLY
```

```
0000:201C   B0 40                MOVB  AL,40      ;Initialize 8251
                                                ;for asynchronous
0000:201E   EE                   OUTB  DX,AL      ;16x baud
0000:201F   E8 28 00             CALL  DLY        ;8 data bits, no
0000:2022   B0 CE                MOVB  AL,0CE     ;parity
0000:2024   EE                   OUTB  DX,AL
0000:2025   E8 22 00             CALL  DLY
0000:2028   B0 27                MOVB  AL,27
0000:202A   EE                   OUTB  DX,AL
0000:202B   E8 1C 00             CALL  DLY
0000:202E   BE 00 21             MOVW  SI,2100
0000:2031   BA CA FF        STS: MOVW  DX,M51
0000:2034   EC                   INB   AL,DX      ;Get USART status
                                                ;for Transmitter
0000:2035   24 81                ANDB  AL,81      ;ready &
0000:2037   3C 81                CMPB  AL,81      ;DSR active
0000:2039   75 F6                JNE   STS
0000:203B   8A 04                MOVB  AL,[SI]    ;If yes, transmit
0000:203D   46                   INCW  SI         ;stored character
0000:203E   3C 00                CMPB  AL,00
0000:2040   74 07                JE    OVR
0000:2042   BA C8 FF             MOVW  DX,V51
0000:2045   EE                   OUTB  DX,AL
0000:2046   E9 E8 FF             JMP   STS
0000:2049   CC              OVR: INT   3
0000:204A   B9 02 00        DLY: MOVW  CX,2
0000:204D   E2 FE                LOOP  204D
0000:204F   C3                   RET
                            ORG   2100       ;Display msg TBL
0000:2100   0D 0A 20 20 57 45
0000:2106   4C 43 4F 4D 45 20 ASC'WELCOME TO ESA STUDY CARD'
0000:210C   54 4F 20 45 53 41
0000:2112   20 53 54 55 44 59
0000:2118   20 43 41 52 44 0D 00
```

Example 2.Program to receive characters from the USART and display it on the console as well as store it in memory location from 0:2100H location onwards. Press <Esc> to stop receiving characters and exit from the loop.

```
ADDRESS   OP-CODES  LABELS    MNEMONICS          COMMENTS
0000:2000                M53   EQU   0FFC6
0000:2000                TM0   EQU   0FFC0
0000:2000                M51   EQU   0FFCA
0000:2000                V51   EQU   0FFC8
0000:2000  B0 36               MOVB  AL,36
0000:2002  BA C6 FF            MOVW  DX,M53     ;Initialize
                                                ;TIMER 0
0000:2005  EE                  OUTB  DX,AL      ;for Mode 3
operation
0000:2006  BA C0 FF            MOVW  DX,TM0
0000:2009  B0 0A               MOVB  AL,0A      ;Load TIMER 0
                                                ;count
```

```
0000:200B  EE                    OUTB  DX,AL      ;for 9600 baud
0000:200C  B0 00                 MOVB  AL,00
0000:200E  EE                    OUTB  DX,AL
0000:200F  BC 00 30              MOVW  SP,3000
0000:2012  BA CA FF              MOVW  DX,M51     ;Reset 8251
0000:2015  EE                    OUTB  DX,AL
0000:2016  EE                    OUTB  DX,AL
0000:2017  EE                    OUTB  DX,AL
0000:2018  EE                    OUTB  DX,AL
0000:2019  E8 43 00              CALL  DLY
0000:201C  B0 40                 MOVB  AL,40      ;Initialize 8251
                                                  ;for asynchronous
0000:201E  EE                    OUTB  DX,AL      ;16x baud, 8 data
0000:201F  E8 3D 00              CALL  DLY        ;bits, no parity
0000:2022  B0 CE                 MOVB  AL,0CE
0000:2024  EE                    OUTB  DX,AL
0000:2025  E8 37 00              CALL  DLY
0000:2028  B0 27                 MOVB  AL,27


0000:202A   EE                   OUTB  DX,AL
0000:202B   E8 31 00             CALL  DLY
0000:202E   BE 00 21             MOVW  SI,2100    ;Initialize
                                                  ; Memory to
0000:2031   BA CA FF      GCH:   MOVW  DX,M51     ;store character
0000:2034   EC                   INB   AL,DX      ;Get USART status
0000:2035   24 02                ANDB  AL,02      ;Receiver ready ?
0000:2037   74 F8                JZ    GCH        ;No, wait
0000:2039   BA C8 FF             MOVW  DX,V51     ;Yes, Get
                                                  ; Character
0000:203C   EC                   INB   AL,DX      ;from USART
0000:203D   3C 1B                CMPB  AL,27      ;If char = <Esc>
0000:203F   8A D8                MOVB  BL,AL      ;Exit
0000:2041   74 1B                JE    OVR
0000:2043   BA CA FF      OPT:   MOVW  DX,M51
0000:2046   EC                   INB   AL,DX      ;Get USART status
0000:2047   24 81                ANDB  AL,81      ;Transmitter
                                                  ;Ready
0000:2049   3C 81                CMPB  AL,81
0000:204B   75 F6                JNE   OPT        ;No, Wait
0000:204D   8A C3                MOVB  AL,BL      ;Send same
                                                  ;character
0000:204F   BA C8 FF             MOVW  DX,V51     ;to USART
0000:2052   EE                   OUTB  DX,AL
0000:2053   88 04                MOVB  [SI],AL
0000:2055   46                   INCW  SI
0000:2056   E9 D8 FF             JMP   GCH
0000:2059   EE                   OUTB  DX,AL
0000:205A   46                   INCW  SI
0000:205B   E9 E5 FF             JMP   OPT
0000:205E   CC            OVR:   INT   3
0000:205F   B9 02 00      DLY:   MOVW  CX,2
0000:2062   E2 FE                LOOP  2062
```

```
0000:2064   C3                      RET
```

Example 3. This program initializes the 8253 timer in Mode 3 (Square wave Generator) and displays the count on the console. Press RESET to exit from the program. Execute this program from 0:2000H location in Serial Mode.

```
ADDRESS   OP-CODES   LABELS     MNEMONICS          COMMENTS
0000:2000                  M53   EQU   0FFC6
0000:2000                  TM2   EQU   0FFC4
0000:2000                  TM0   EQU   0FFC0
0000:2000   B0 76              MOVB  AL,76       ;Initialize
                                                 ;TIMER 1
0000:2002   BA C6 FF           MOVW  DX,M53      ;for  Mode 3
                                                 ;operation
0000:2005   EE                 OUTB  DX,AL
0000:2006   B0 FF              MOVB  AL,0FF
0000:2008   BA C2 FF           MOVW  DX,TM1      ;Load TIMER 1
                                                 ;data
0000:200B   EE                 OUTB  DX,AL       ;LSB  first
0000:200C   EE                 OUTB  DX,AL       ; Load MSB
0000:200D   B0 96              MOVB  AL,96       ;Initialize
                                                 ;TIMER 2
0000:200F   BA C6 FF           MOVW  DX,M53
0000:2012   EE                 OUTB  DX,AL
0000:2013   B0 FF              MOVB  AL,0FF
0000:2015   BA C4 FF    ODT:   MOVW  DX,TM2      ;Load TIMER 2
                                                 ; Data

0000:2018   EE                 OUTB  DX,AL
0000:2019   9A 31 00 00 FE     CALLS 0FE00:0031  ;Display message
0000:201E   BE 60 20           MOVW  SI,2060     ;Timer Count = '
0000:2021   9A AF 01 00 FE     CALLS 0FE00:01AF ;on console
0000:2026   B0 86          BCK:MOVB  AL,86
0000:2028   BA C6 FF           MOVW  DX,M53      ;Latch Command
                                                 ; Word
0000:202B   EE                 OUTB  DX,AL
0000:202C   BA C4 FF           MOVW  DX,TM2      ;Read count
0000:202F   EC                 INB   AL,DX
0000:2030   3C 00              CMPB  AL,00
0000:2032   74 E1              JE    ODT
0000:2034   B4 00              MOVB  AH,00
0000:2036   9A 52 00 00 FE     CALLS 0FE00:0052      ;Display
                                                     ;count value
0000:203B   B0 08              MOVB  AL,08           ;on console
0000:203D   9A 00 00 00 FE     CALLS 0FE00:0000
0000:2042   9A 00 00 00 FE     CALLS 0FE00:0000
0000:2047   B9 00 04           MOVW  CX,0400
0000:204A   E2 FE              LOOP  204A
0000:204C   EB D8              JMP   BCK             ;Repeat
                                                    ;continuously
                               ORG   2060
0000:2060   54 49 4D 45 52
```

```
0000:2065   20 43 4F 55 4E
0000:206A   54 20 00                ASC 'TIMER COUNT = `
                                    DB   00
```

Example 4. This program initializes the 8251 for 110 baud and displays the following message on the console. Enter and execute the program from 0:2000H location.

ESA 8251/53 STUDY CARD
DEMONSTRATION PROGRAM FOR 110 BAUD

Note: Set receiving terminal to receive data at 110 baud

```
ADDRESS     OP-CODES   LABELS    MNEMONICS       COMMENTS
0000:2000                M53     EQU   0FFC6
0000:2000                TM0     EQU   0FFC0
0000:2000                M51     EQU   0FFCA
0000:2000                V51     EQU   0FFC8
0000:2000   B0 36                MOVB  AL,36
0000:2002   BA C6 FF             MOVW  DX,M53     ;Initialize
                                                  ;timer 0
0000:2005   EE                   OUTB  DX,AL      ;For mode 3
                                                  ;operation
0000:2006   BA C0 FF             MOVW  DX,TMO
0000:2009   B0 69                MOVB  AL,69      ;Load TMER 0
                                                  ;Count
0000:200B   EE                   OUTB  DX,AL      ;for 110 baud
0000:200C   B0 03                MOVB  AL,03
0000:200E   EE                   OUTB  DX,AL
0000:200F   BC 00 30             MOVW  SP,3000
0000:2012   B0 00                MOVB  AL,00
0000:2014   BA CA FF             MOVW  DX,M51     ;Reset USART
0000:2017   EE                   OUTB  DX,AL
0000:2018   EE                   OUTB  DX,AL
0000:2019   EE                   OUTB  DX,AL
0000:201A   EE                   OUTB  DX,AL



0000: 201B  E8 2E 00             CALL  DLY
0000: 201E   B0 40               MOVB  AL,40
0000: 2020   EE                  OUTB DX,AL
0000: 2021   E8 28 00            CALL  DLY
0000: 2024   B0 CE               MOVB  AL,OCE
0000: 2026   EE                  OUTB  DX/AL
0000: 2027   E8 22 00            CALL  DLY
0000: 202A   B0 27               MOVB  AL,27
0000: 202C   EE                  OUTB  DX,AL
0000: 202D   E8 1C 00            CALL  DLY
0000: 2030   BE 00 21            MOW   SI/2100
0000: 2033   BA CA FF       STS: MOVW  DX,M51     ;Get USART status
                                                  ;for transmitter
```

```
0000: 2036   EC                  INB   AL,DX      ;ready and
0000: 2037   24 81               ANDB  AL/81      ;DSR active
0000: 2039  3C 81                CMPB  AL/81      ;No/ wait till it
0000: 203B  75 F6                JNE   STS        ;becomes active
0000: 203D  8A 04                MOVB  AL,[SI]    ;If yes, transmit
0000: 204F  46                   INCW  SI         ;stored character
0000: 2040  3C 00                CMPB  AL,00
0000: 2042  74 06                JE    OVER
0000: 2044  BA C8 FF             MOVW  DX,V51
0000: 2047  EE                   OUTB  DX,AL
0000: 2048  EB E9                JMP   STS
0000: 204A  CC              OVR: INT   3
0000: 204B  B9 02 00        DLY: MOVW CX,2
0000: 204E  E2 FE                LOOP  204E
0000: 2050   C3                  RET

                                 ORG 2100         ;Display look-up
                                                  ;table
0000: 2100  44 45 4D 4F      ASC'DEMO PROGRAM FOR 110 BAUD'
0000: 2104   20 50 52 4F
0000:2108  47 52 41 4D
0000:210C  20 46 4F 52
0000:2110  20 31 31 30
0000:2114  20 42 41 55
0000:2115  44 0D 00
```