IC 82C55

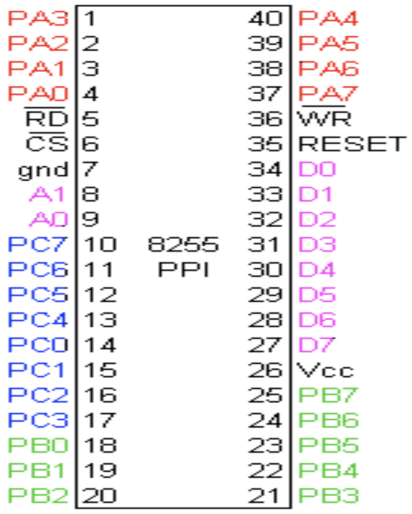
The 82C55 programmable peripheral interface (PPI) is a very popular low-cost interfacing component that is used in many applications.

- It is a 40 pin IC/PPI
- It has 3 ports - Port A, Port B, Port C - to connect I/O devices
- Each port has 8 pins for data transmission from any I/O device
- 8 pins for control words/ data/ instruction transmission - MPU (Microprocessor Unit) to IC
- **V_cc**: Powers the IC
- **GND**: prevents overpower/ balances the power
- **CS = 0** : Activates the IC
- **RD = 0**: MPU Reads from the IC buffer
- **WR = 0**: MPU writes to the IC buffer
- **A1, A0** : Selects port

A1	A0	PORT
0	0	PORT A
0	1	PORT B
1	0	PORT C
1	1	Command Register

- **RESET**: Reconfigures the IC

Pin Diagram:



- PA0-PA7:It is the 8-bit bi-directional I/O pins used to send the data to the peripheral or to receive the data from the peripheral.

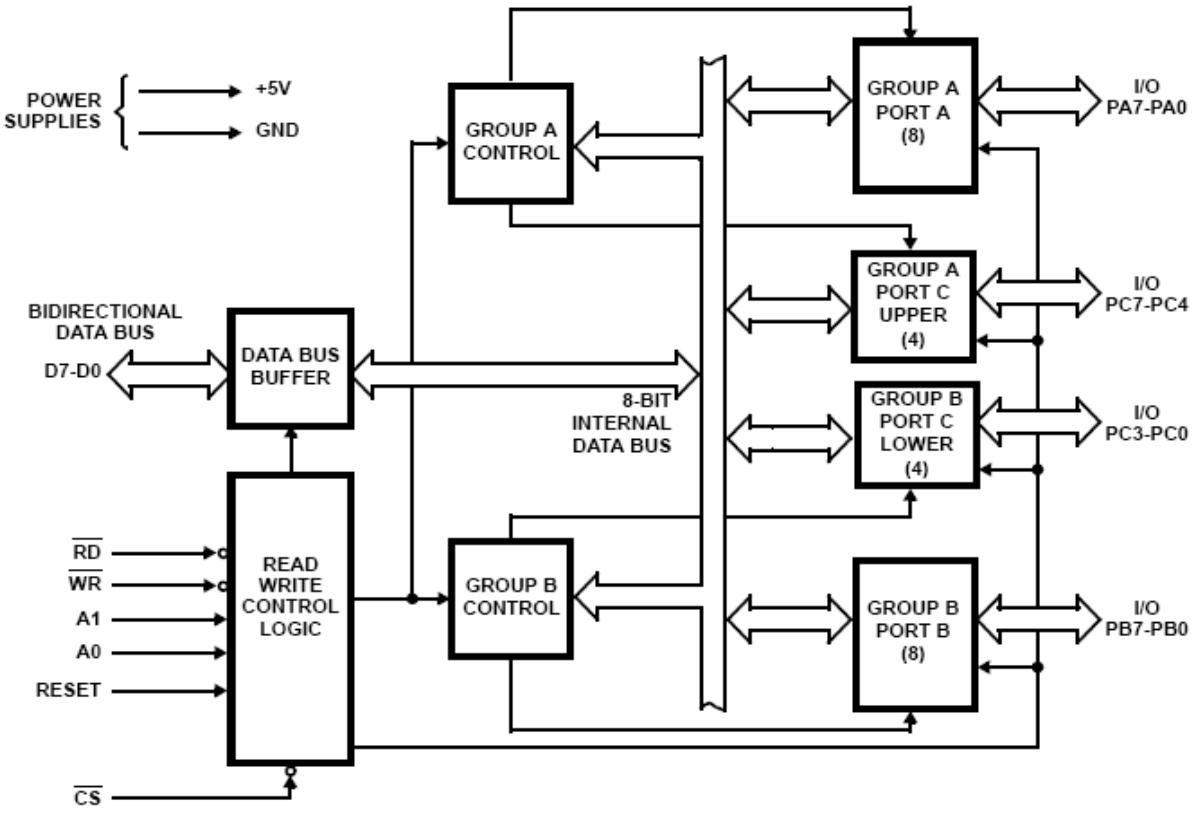
- PB0-PB7:Similar to PA

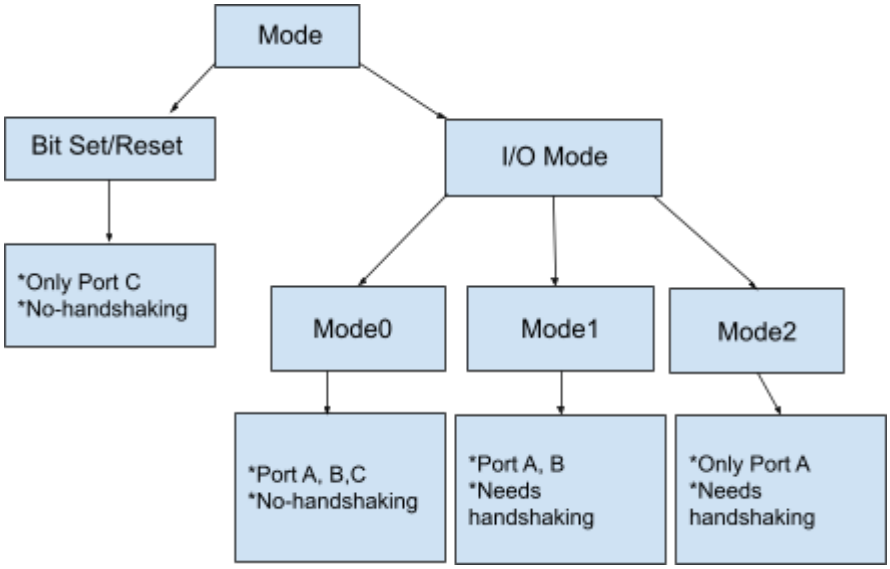
- PC0-PC7:This is also 8-bit bidirectional I/O pins. These lines are divided into two groups.
  PC0 to PC3(Lower Groups)
  PC4 to PC7 (Higher groups)

**** DATA BUS:** It is a 8-bit bidirectional Data bus. Used to interface between 82C55 data bus and system bus. The internal data bus and Outer pins D0-D7 pins are connected internally.The direction of the data buffer is decided by Read/Control Logic.

Following Table gives the basic operation,

A_1	A_0	$\overline{RD}$	$\overline{WR}$	$\overline{CS}$	Input operation
0	0	0	1	0	PORT A → Data bus
0	1	0	1	0	PORT B → Data bus
1	0	0	1	0	PORT C → Data bus
0	0	1	0	0	Output operation Data bus → PORT A
0	1	1	0	0	Data bus → PORT B
1	0	1	0	0	Data bus → PORT C
1	1	1	0	0	Data bus → control





Mode0 - Only low level devices - LED, Buzzer, Switch
Mode1 - High Level Unidirectional Devices - Mouse, Keyboard, Printer
Mode2 - High Level Bi-directional Device - Hard drive, Touchscreen

Mode is decided by the 8 bit "control bits" sent from the MPU to the IC*

Control bits:

D7	D6	D5	D4	D3	D2	D1	D0

D7: 0 -> Bit Set/Reset Mode
D7: 1 -> I/O Mode

Bit Set/Reset Mode

We use bit set/reset mode when the MPU needs to set/reset or configure/reconfigure any device which is only connected to port C.

Control bits:

D7	D6	D5	D4	D3	D2	D1	D0

1. **D7 : 0 - Defines how the IC will configure itself in bit set reset mode**
2. **D6, D5,D4: X,X,X (DON'T CARE)**
3. **D3, D2, D1: Selects from which pin of port C the actual data will be transmitted**

D3	D2		D1	Port C pin
0	0		0	0
0	0		1	1
0	1		0	2
0	1		1	3
1	0		0	4
1	0		1	5
1	1		0	6
1	1		1	7

4. **D0: Sends the actual data to the IC**
   D0 -> 1 - Means Set the device
   D0 -> 0 - Means Reset the device

I/O MODE

We use I/O mode when different types of I/O devices are connected to the IC and want to communicate with the microprocessor.

Control bits:

D7	D6	D5	D4	D3	D2	D1	D0

1. **D7: 1 - Defines the IC will configure itself in bit I/O mode**

2. **D6,D5: Selects the mode in which Port A will work**
   00 - MODE0
   01 - MODE1
   10 - MODE2

3. **D4: defines what type of device (Input device / Output device) is connected to port A**
   D4 -> 1 - INPUT DEVICE
   D4 -> 0 - OUTPUT DEVICE

4. **D3: Defines what type of device (Input device / Output device) is connected with the upper 4 pins (PC7-PC4) of port C**
   D3 -> 1 - INPUT DEVICE
   D3 -> 0 - OUTPUT DEVICE
   D3 -> X - All 4 pins are busy in handshaking

5. **D2: Selects the mode in which Port B will work**
   0 - MODE0
   1 - MODE1

6. **D1: defines what type of device (Input device / Output device) is connected to port B**
   D1 -> 1 - INPUT DEVICE
   D1 -> 0 - OUTPUT DEVICE

7. **D0: Defines what type of device (Input device / Output device) is connected with the lower 4 pins (PC0-PC3) of port C**
   D0 -> 1 - INPUT DEVICE
   D0 -> 0 - OUTPUT DEVICE
   D0 -> X - All 4 pins are busy is handshaking

Example 1 : In port A, 1 printer is connected and in port B and C 4 LEDs are connected. Write the control bits.

1	0	1	0	x	0	0	0

Example : In port A, 1 printer is connected and in port B 1 keyboard is connected. Write the control bits.

1	0	1	0	x	1	1	x

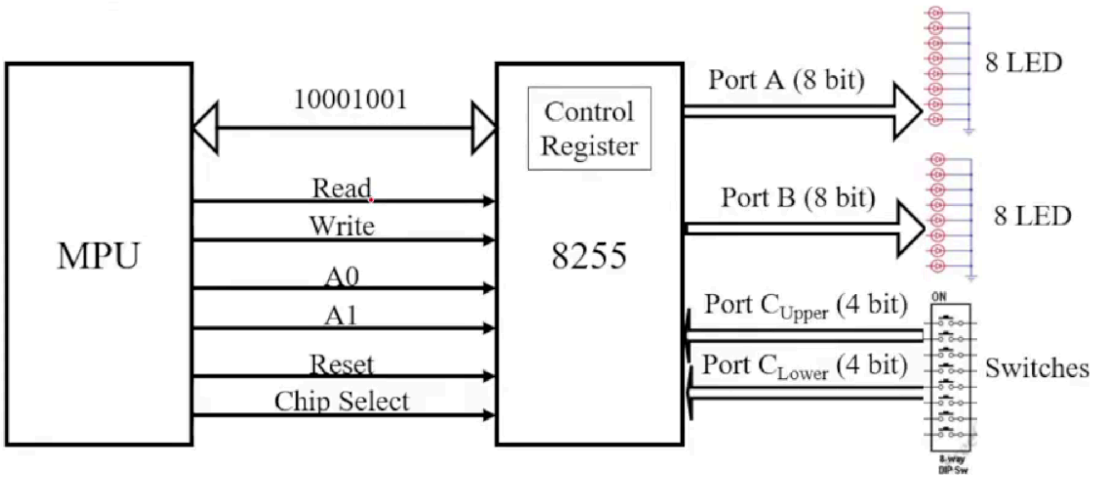
Example 3: In port B, 1 keyboard is connected and in port A 5 switches are connected and in port C 3 LEDs are connected. Write the control bits.

1	0	0	1	0	1	1	x

Example 4: In port A, 1 pendrive is connected and in port B 4 switches are connected. Write the control bits.

1	1	x	x	x	0	1	x

Mode0 - Communication (No Handshaking)



Mode0 works for only low level devices
outputs are - Latched [1 bit], inputs are - Buffered [8 bit]
Steps:

1. MPU selects the IC/ activates the IC with CS = 0
2. A1, A0 = 1,1 and activates the command registers/ prepares the IC to configure
3. WR = 0
4. Sends 8 bit control bits through the databus [Here, 10001001]
5. Once IC is configured further data is transmitted through the data bus line

Handshaking

Handshaking is a I/O control method to synchronize I/O devices with the microprocessor

Handshaking

Mode0 - No Handshaking

Mode1 -

- Input handshaking
- Output handshaking

Mode2 -

- Input handshaking
- Output handshaking

Mode1 - Handshaking

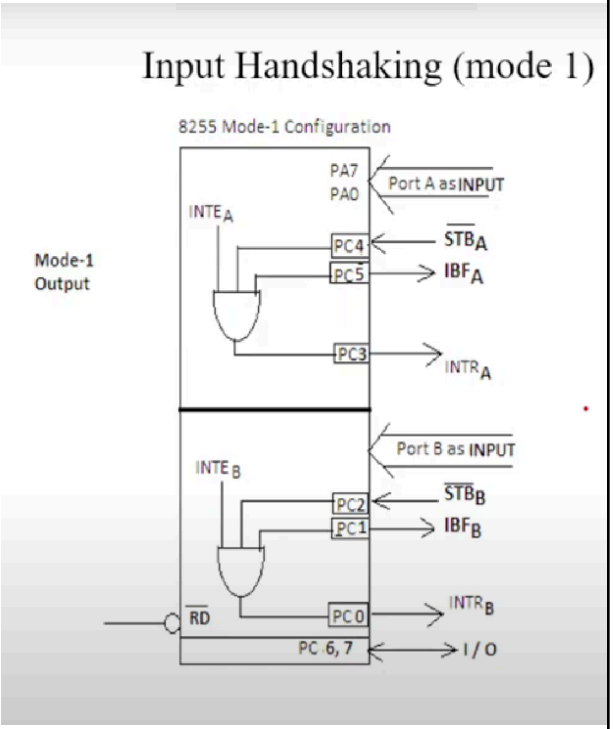
Input Handshaking:

Steps (PORT A):

1. Device sends 8 bit data to data buffer of the IC through PA0-PA7
2. Immediately the strobe signal (STB_A =0) is sent from device to IC through PC4 to let the IC know that data is being sent
3. Once the data bus buffer is filled with data the input buffer full (IBF_A = 1) signal is sent from IC to device through PC5
4. STB_A = 1
5. INTR_A = 1 is sent from PC3 from IC to MPU for receiving the data
6. If MPU wants, RD = 0 and reads the data
7. INTR_A = 0, IBF_A = 0

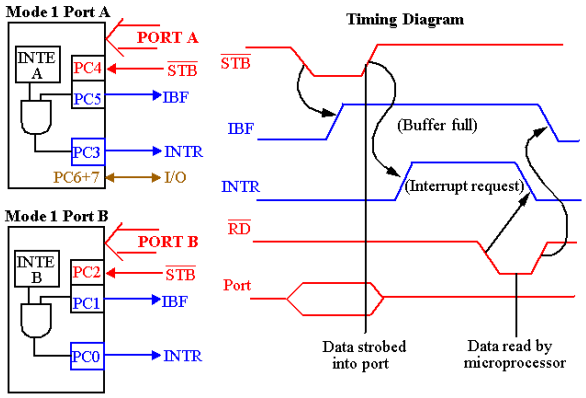
Steps (PORT B):

1. Device sends 8 bit data to data buffer of the IC through PB0-PB7
2. Immediately the strobe signal (STB_B = 0) is sent from device to IC through PC2 to let the IC know that data is being sent
3. Once the data bus buffer is filled with data the input buffer full (IBF_B = 1) signal is sent from IC to device through PC1
4. STB_B = 1
5. INTR_B = 1 is sent from



PC0 from IC to MPU for receiving the data 6. If MPU wants, RD = 0 and reads the data 7. INTR_B = 0, IBF_B = 0	

Timing diagram of input handshaking (Mode 1):

$\overline{STB}$ The strobe input loads data into the port latch on a 0-to-1 transition IFB **Input buffer full** is an output indicating that the input latch contain information INTR **Interrupt request** is an output that requests an interrupt INTE The **interrupt enable signal** is neither an input nor an output; it is an internal bit programmed via the PC4(port A) or PC2(port B) bits. PC7,PC6 The port C pins 7 and 6 are general-purpose I/O pins that are available for any purpose.	

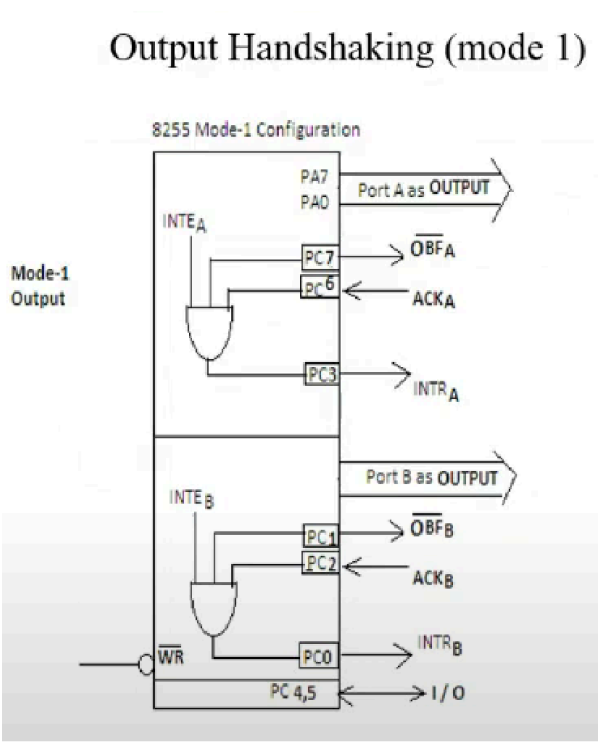
Output Handshaking:

Steps (PORT A):

1. INTR_A = 1 is sent from PC3 from the device via IC to the MPU to check if there is any data to output.
2. If there is, MUP -> WR = 0 and sends data to the data bus buffer of the IC
3. IC sends the MPU output buffer full signal (OBF_A = 0) through PC7 to tell the device to take data
4. INTR_A = 0
5. Once the device is ready it sends ACK_A = 0 to the IC through PC6
6. The device then takes data from the data bus buffer through PA0-PA7 for providing output
7. Once all data is taken, OBF_A = 1, INTR_A = 1

Steps (PORT B):

1. INTR_B = 1 is sent from PC0 from the device via IC to the MPU to check if there is any data to output
2. If there is, MUP -> WR = 0 and sends data to the data bus buffer of the IC
3. IC sends the MPU output buffer full signal (OBF_B = 0) through PC1 to tell the device to take data
4. INTR_B = 0
5. Once the device is ready it sends ACK_B = 0 to the IC through PC2



*

ACK will be an active low pin in the image

6. The device then takes data from the data bus buffer through PB0-PB7 for providing output 7. Once all data is taken, OBF_B = 1, INTR_B = 1	

Mode 1 - input handshaking - free pins/ available to connect low level devices to Port C - Pin 6,7
Mode 1 - output handshaking - free pins/ available to connect low level devices to Port C - Pin 4,5

Example 1: Port A/ Port B is connected to an Input device. Write the handshaking steps.
Ans. same as described above

Example 2: Port A/ Port B is connected to an Output device. Write the handshaking **steps.**
Ans. same as described above

Example 3: Port A is connected to an input device and Port B is connected to an output device. Write the handshaking steps.

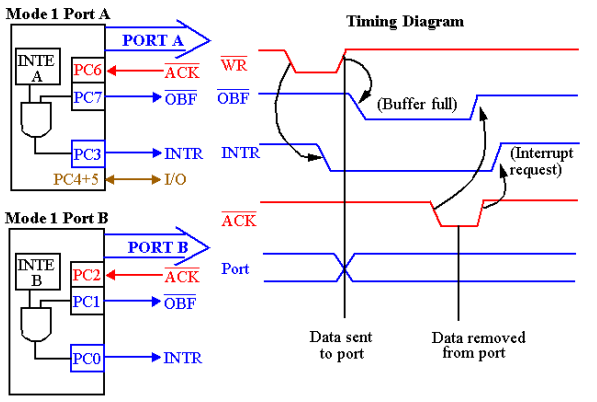
Ans. In this case MPU removes the redundant INTR pin usage. And for both cases the INTR signal goes from PC3 of Port C. Rest of the process is the same. In this case, Pin PC0, PC6, PC7 are free to connect low level devices.

Example 4: Port B is connected to an input device and Port A is connected to an output device. Write the handshaking steps.

Ans. In this case MPU removes the redundant INTR pin usage. And for both cases the INTR signal goes from PC3 of Port C. Rest of the process is the same. In this case, Pin PC0, PC4, PC5 are free to connect low level devices.

Timing diagram of output handshaking (Mode 1):

$\overline{OBF}$	**Output buffer full** is an output that goes low when data is latched in either port A or port B. Goes low on $\overline{ACK}$.
$\overline{ACK}$	The **acknowledge** signal causes the $\overline{OBF}$ pin to return to 0. This is a response from an external device.
INTR	**Interrupt request** is an output that requests an interrupt
INTE	The **interrupt enable signal** is neither an input nor an output; it is an internal bit programmed via the PC6(port A) or PC2(port B) bits.
PC5,PC4	The port C pins 5 and 4 are general-purpose I/O pins that are available for any purpose.



Mode 2 - Handshaking

In mode 2, only bi-directional I/O devices can be connected. In this case the MPU hands over the control to the 82C55 IC right after only sending the control bits to the IC. With each clock pulse the IC configures itself either in input mode or output mode. When the device inputs any data the IC processes it during the input clock pulse and when the device needs to output any data the IC processes it during output clock pulse.

Input & Output handshaking:

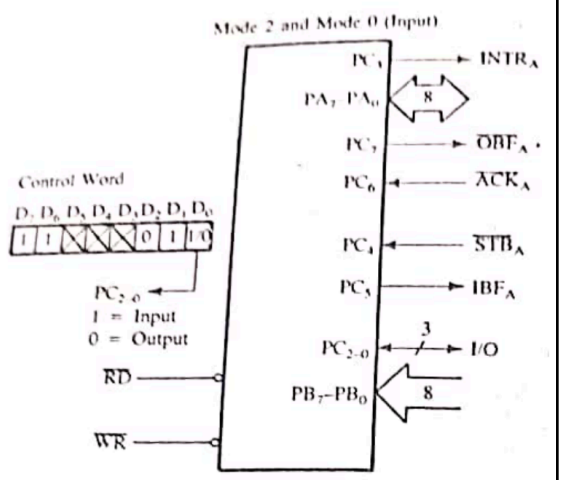
Case 1: when port A is connected to a High-level bidirectional device and port B and port C is connected to low level device

Control Bits:

1	1	x	x	x	0	1/0	1/0
D7	D6	D5	D4	D3	D2	D1	D0

D1 - 1 - for input device
0 - for output device
D0 - 1 - for input device
0 - for output device
D3 - Fully dedicated to port A for handshaking

Steps: The Signals work just as mode 1 during the Input/ Output clock pulse of the 82C55 IC with different pin configuration.
Explain by yourself



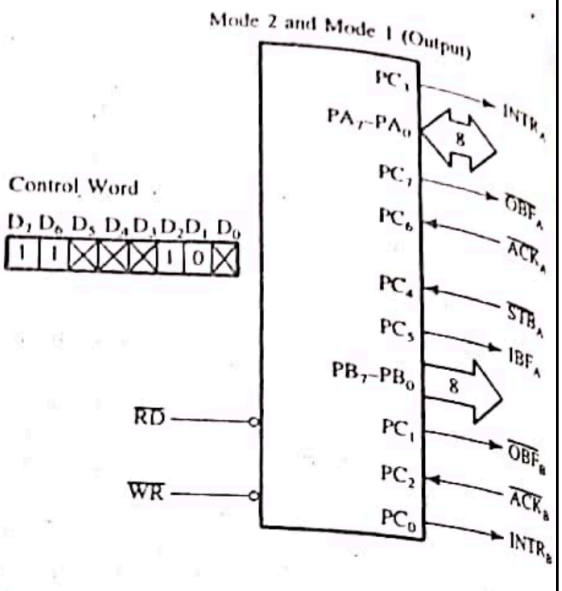
Case 2: when port A is connected to a High-level bidirectional device and port B is connected to high-level unidirectional device

Control Bits:

1	1	x	x	x	1	1/0	x
D7	D6	D5	D4	D3	D2	D1	D0

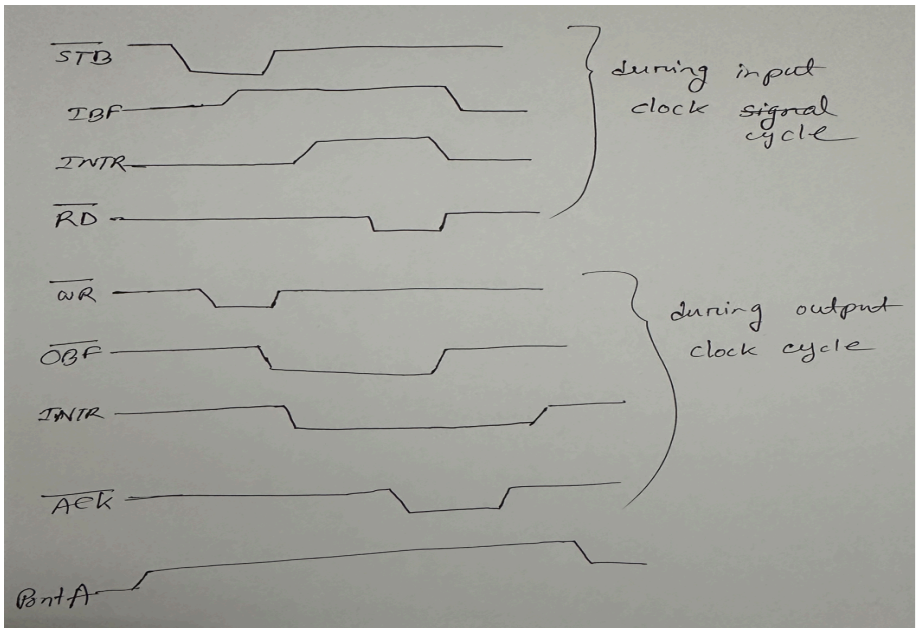
D1 - 1 - for input device
0 - for output device
D3 & D0 - Fully dedicated to port A and Port B for handshaking

Steps: The Signals work just as mode 1 during the Input/ Output clock pulse of the 82C55 IC with different pin configuration.

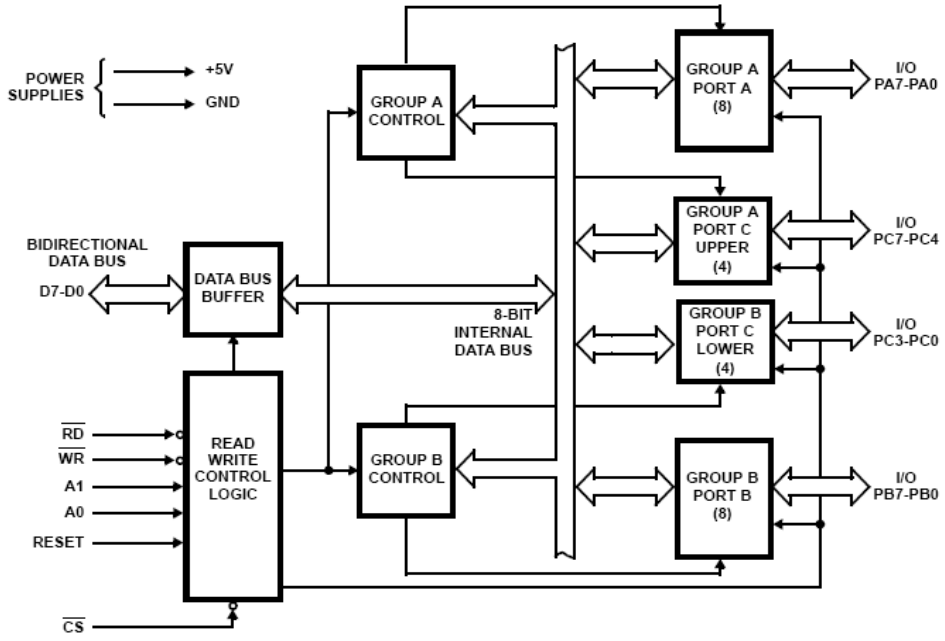


Explain by yourself	

Timing diagram of handshaking (Mode 2):



How MPU and 82C55 communicates



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