DEVICES AND COMMUNICATION BUSES FOR DEVICES NETWORK–

Lesson-18: SERIAL BUS COMMUNICATION PROTOCOLS – I^2C

Interconnecting number of device circuits,

- Assume flash memory, touch screen, ICs for measuring temperatures and ICs for measuring pressures at a number of processes in a plant.
- ICs mutually network through a common synchronous serial bus I^2C
- An 'Inter Integrated Circuit' (I2C) bus, a popular bus for these circuits.

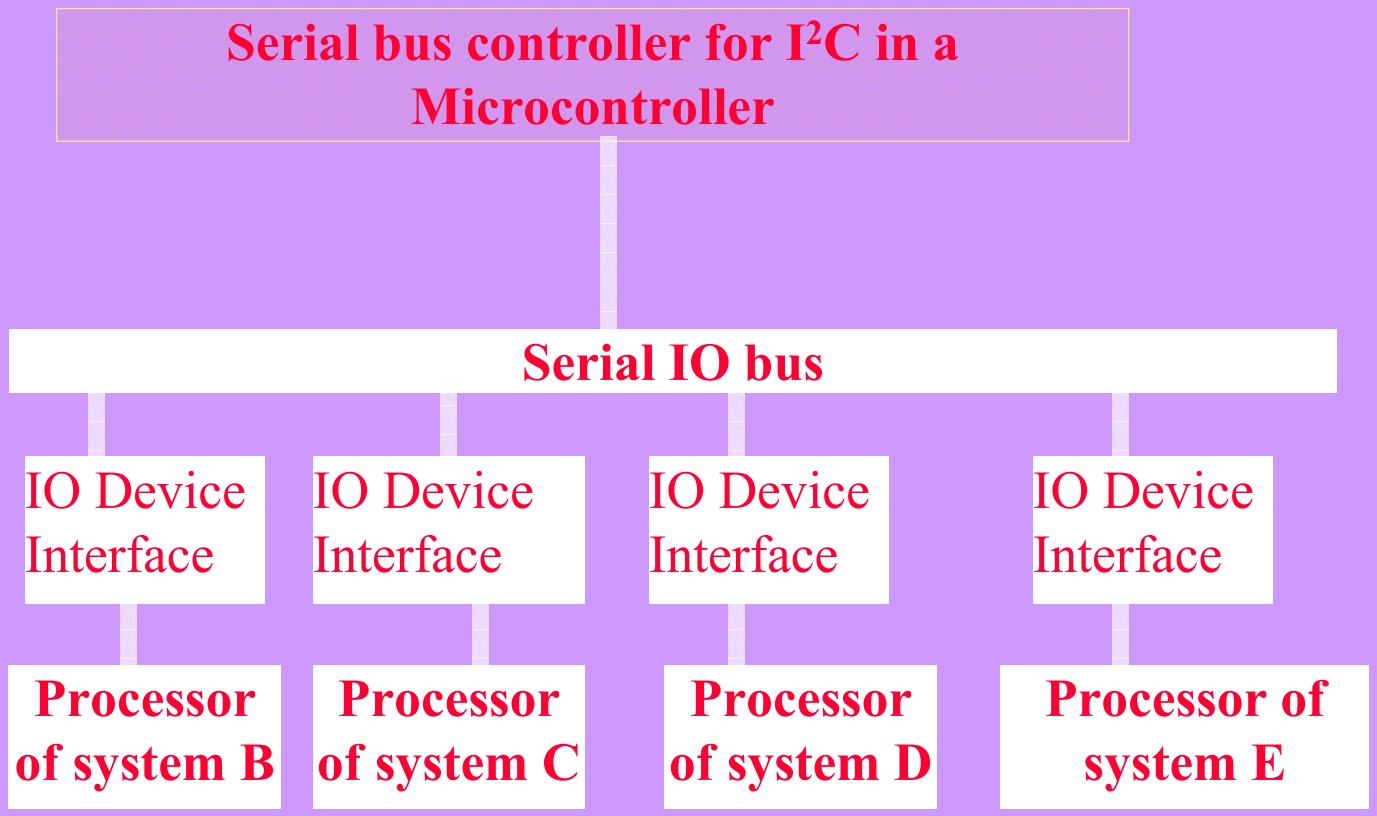
Synchronous Serial Bus Communication for networking

- Each specific I/O synchronous serial device may be connected to other using specific interfaces, for example, with I/O device using I^2C controller
- I^2C Bus communication– use of only simplifies the number of connections and provides a common way (protocol) of connecting different or same type of I/O devices using synchronous serial communication

IO I^2C Bus

- Any device that is compatible with a I^2C bus can be added to the system (assuming an appropriate device driver program is available), and a I^2C device can be integrated into any system that uses that I^2C bus.

Serial IO I^2C bus



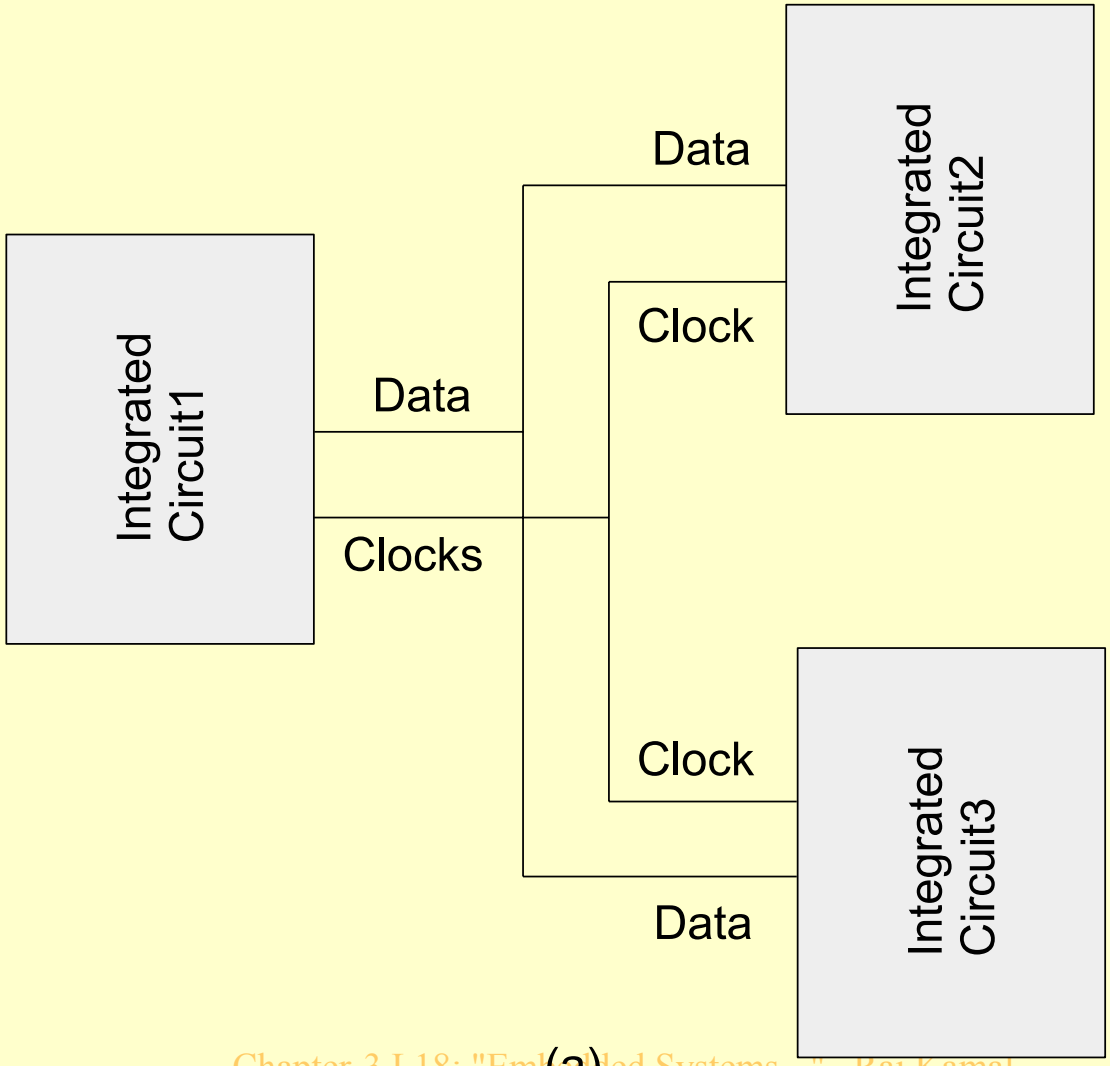
Originally developed at Philips Semiconductors

Synchronous Serial Communication 400 kbps up to 2 m and 100 kbps for longer distances

Three I^2C standards

- Industrial 100 kbps I^2C,
- 100 kbps SM I2C,
- 400 kbps I^2C

Distributed Systems (ICs) on I^2C Bus using serial data line and clock



(a)

I^2C Bus

- The Bus has two lines that carry its signals— one line is for the clock and one is for bi-directional data.
- There is a standard protocol for the I^2C bus.

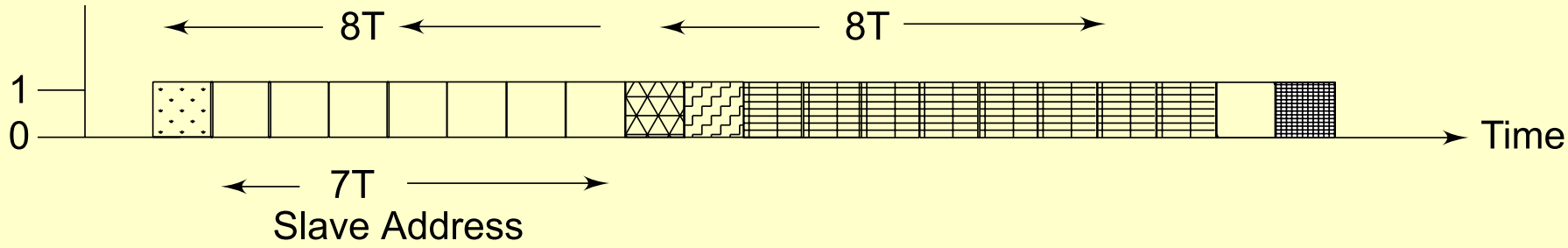
Device Addresses and Master in the I^2C bus

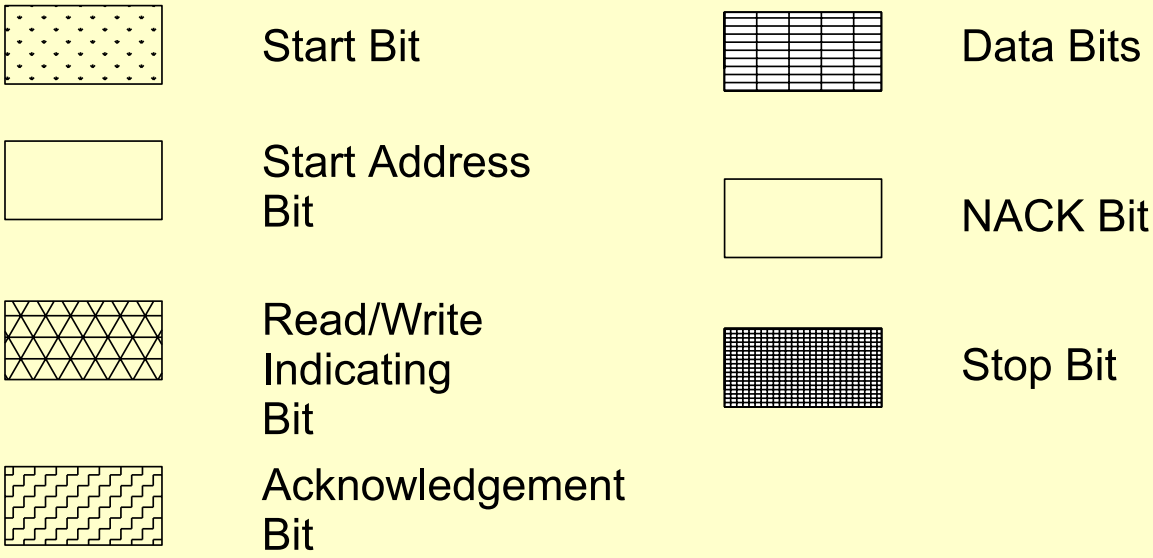
- Each device has a 7-bit address using which the data transfers take place.
- Master can address 127 other slaves at an instance.
- Master has at a processing element functioning as bus controller or a microcontroller with I^2C (Inter Integrated Circuit) bus interface circuit.

Slaves and Masters in the I^2C bus

- Each slave can also optionally has I^2C (Inter Integrated Circuit) bus controller and processing element.
- Number of masters can be connected on the bus.
- However, at an instance, master is one, which initiates a data transfer on SDA (serial data) line and which transmits the SCL (serial clock) pulses. From *master*, a data frame has fields beginning from start bit

Bits as per I²C Bus Protocol





(b)

Synchronous Serial Bus Fields and its length

- First field of 1 bit– Start bit similar to one in an UART
- Second field of 7 bits– address field. It defines the slave address, which is being sent the data frame (of many bytes) by the master
- Third field of 1 control bit– defines whether a read or write cycle is in progress
- Fourth field of 1 control bit– defines whether is the present data is an acknowledgment (from slave)

Synchronous Serial Bus Fields and its length

- Fifth field of 8 bits— **I^2C device data byte**
- Sixth field of 1-bit— bit NACK (negative acknowledgement) from the receiver. If active then acknowledgment after a transfer is not needed from the slave, else acknowledgement is expected from the slave
- Seventh field of 1 bit — stop bit like in an UART

Disadvantage of I^2C bus

- Time taken by algorithm in the hardware that analyzes the bits through I^2C in case the slave hardware does not provide for the hardware that supports it.
- Certain ICs support the protocol and certain do not.
- Open collector drivers at the master need a pull-up resistance of 2.2 K on each line

Summary

We learnt

- I^2C is a serial bus for interconnecting the ICs.
- A start bit and a stop bit like in UART.
- It has seven fields for start, 7-bits address, defining a read or write, definition of byte as acknowledging byte, data byte, NACK and end bit.

End of Lesson 18 of Chapter 3