Interfacing Keyboard with MPU *without Peripheral Controller*

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Outline

- Peripheral communications
- Keyboard
  - Simple Switch
  - One Dimensional Keyboard (PIANO)
  - Two Dimensional (Matrix) Keyboard
- Interfacing 1D Keyboard
- Interfacing Matrix Keyboard
- Modern Keyboard & Scan code
- Timer and Peripheral Controller

Transmission controller (low speed I/O)

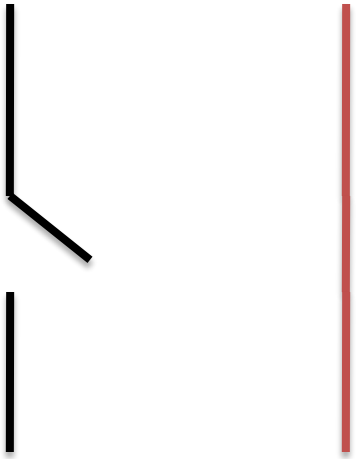
- Transmission Controller:
  - **MPU control**, Device Control (DMA)
- Type of IO mapping
  - **Peripheral (IN/Out)**, Memory mapped IO (LD/ST,MV)
- Format of communication
  - Synchronous (T & R sync with clock), **Asynchronous**
- Mode of Data Transfer
  - Parallel, **Serial (UART)**
- Condition for data transfer
  - Uncond., Polling**, Interrupt**, Ready signal, Handshake

Keyboard Vs Display

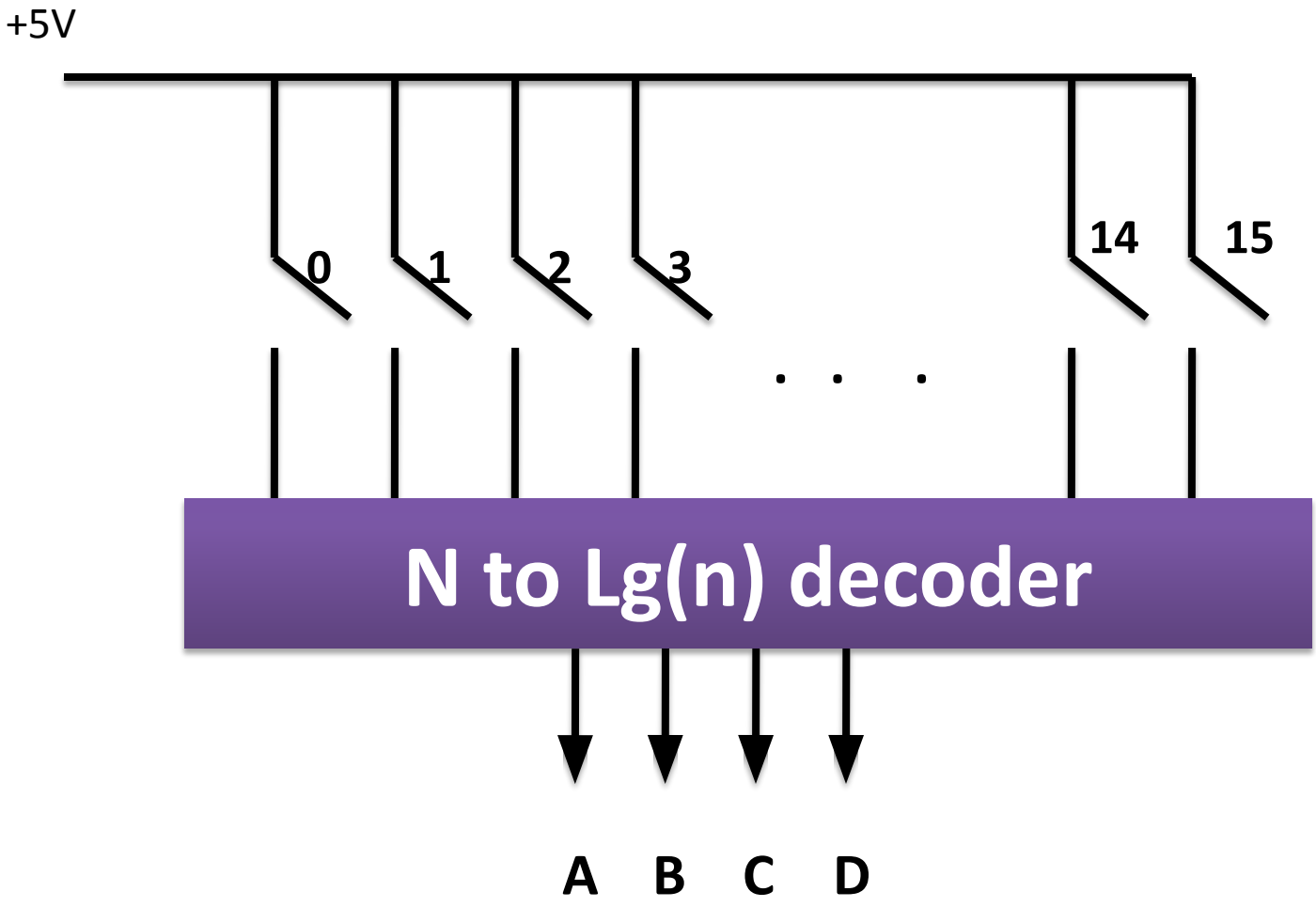
- Display: Human can’t see the difference after 50Hz
  - Displaying speed more then 50Hz is value less
  - Human problem, Computer is faster
- Key board
  - Computer have to wait for the user Keyboard response
  - Only interrupt or Read form ready buffer

Keyboard

- Keyboard is an input device
- Switch:



How Keyboard work ? ==1D



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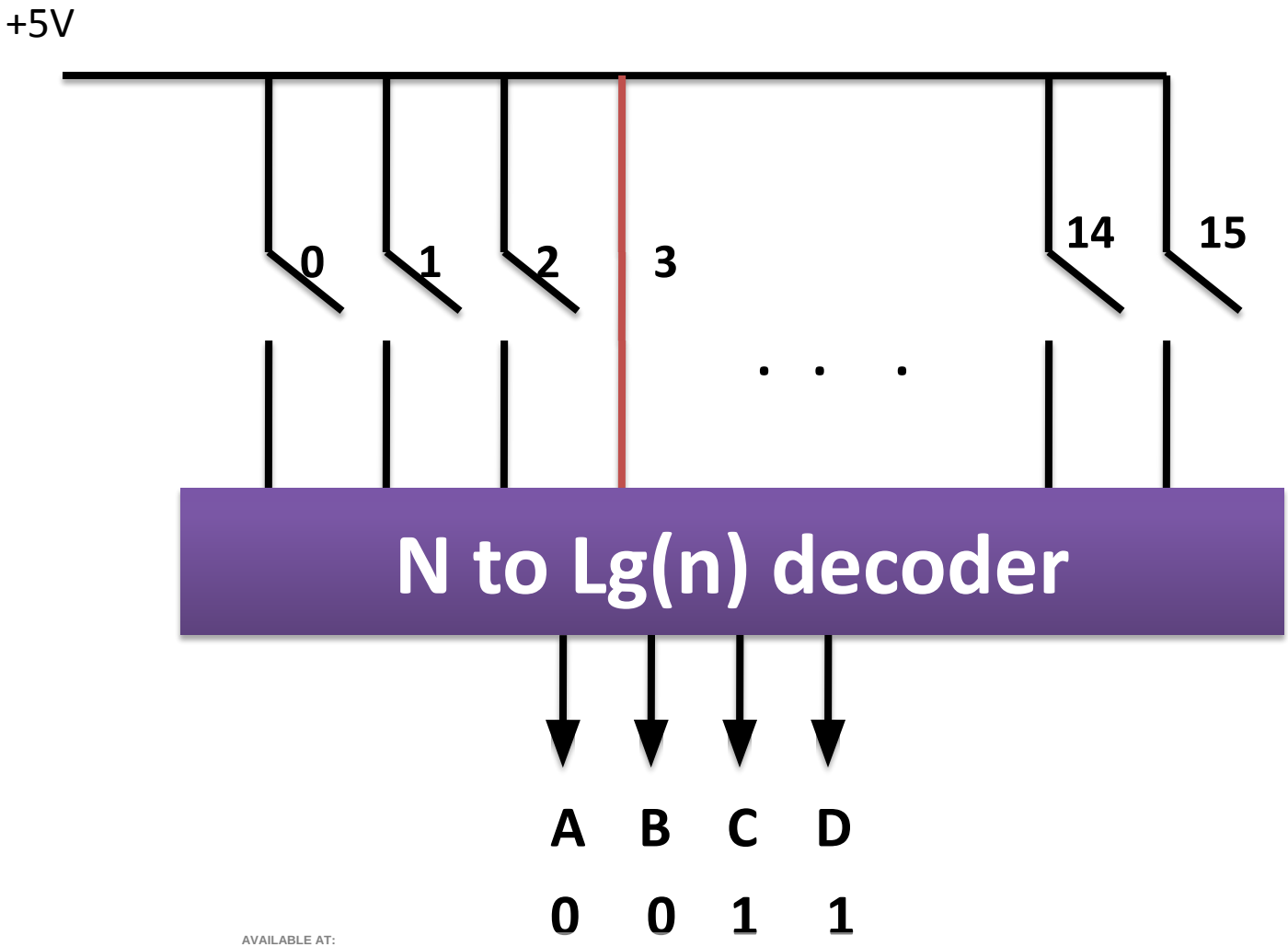

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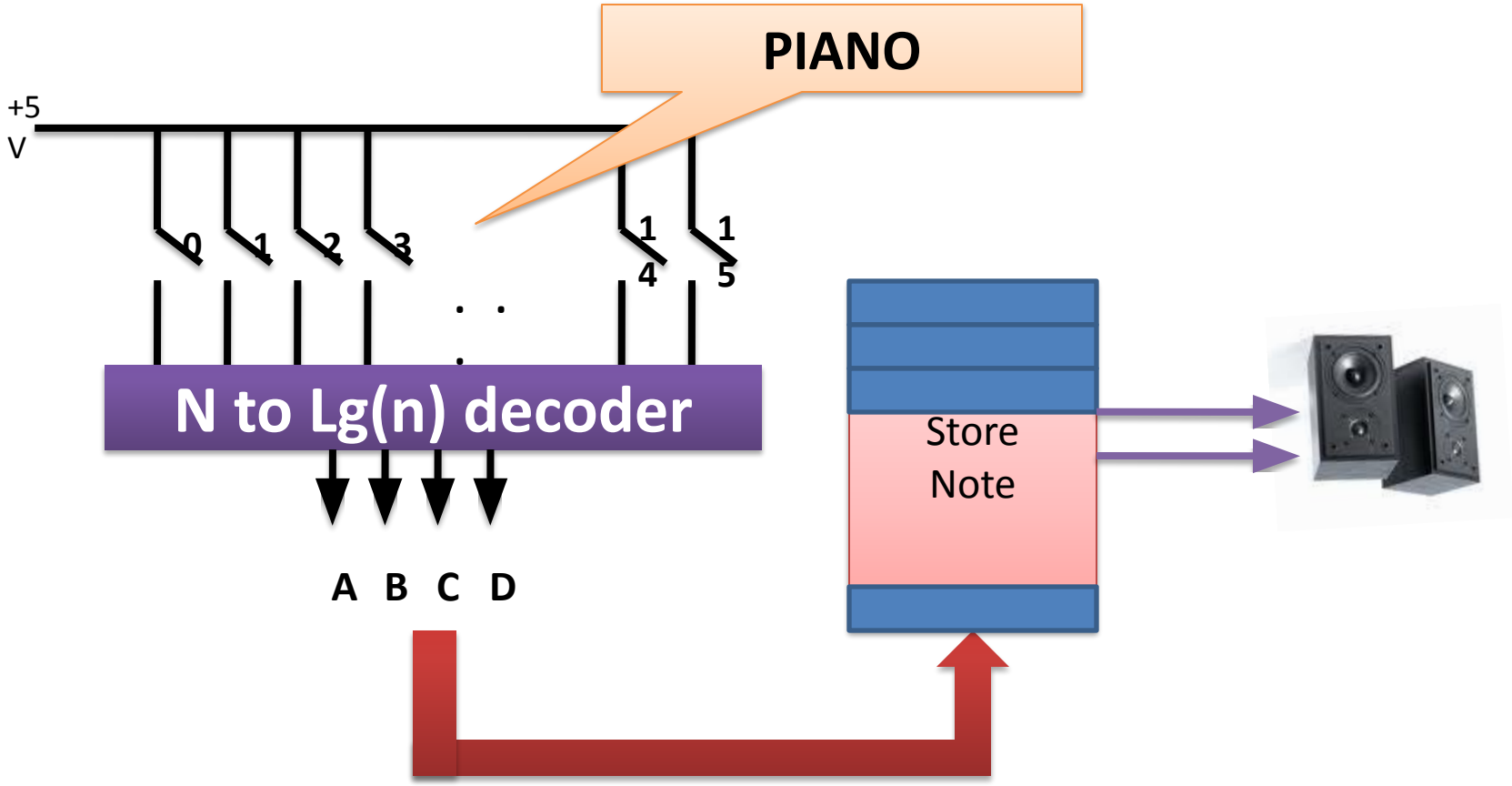
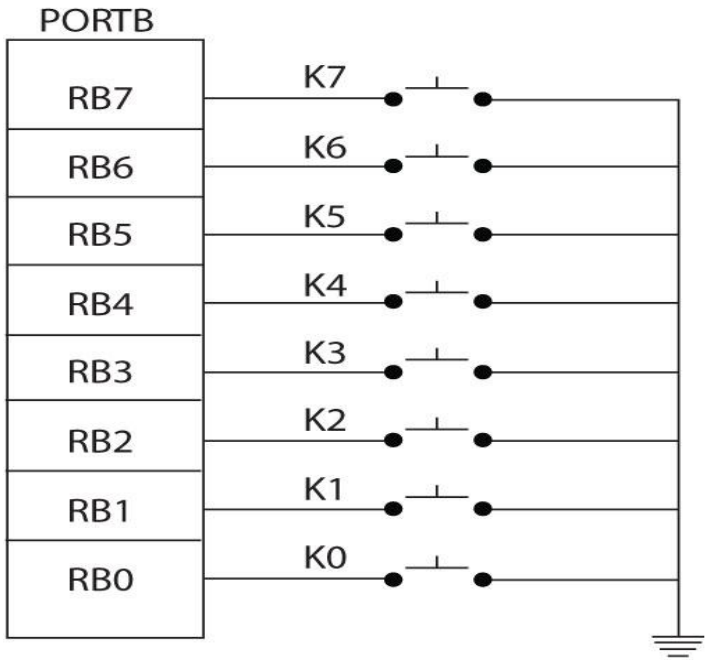
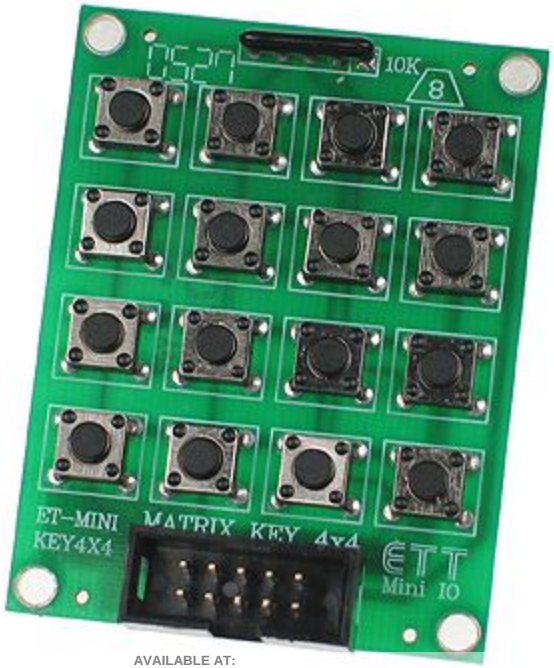


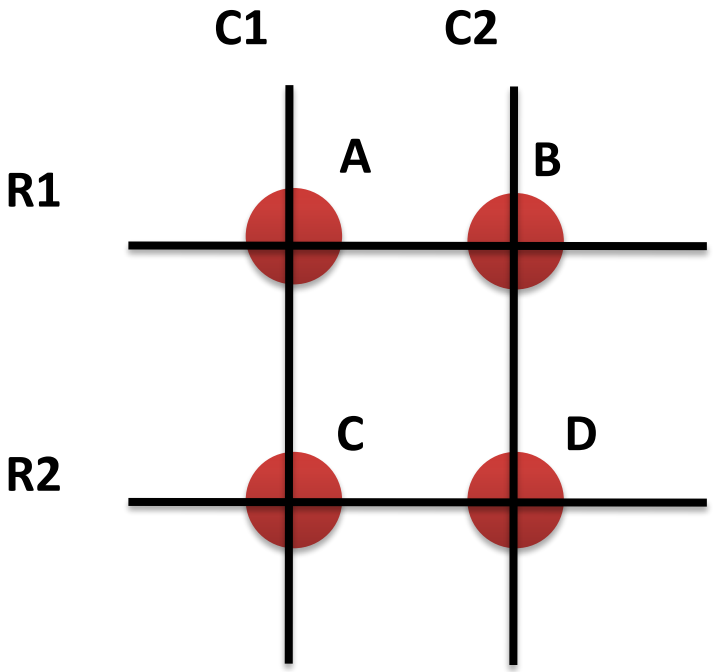
Interfacing Push-Button Keys

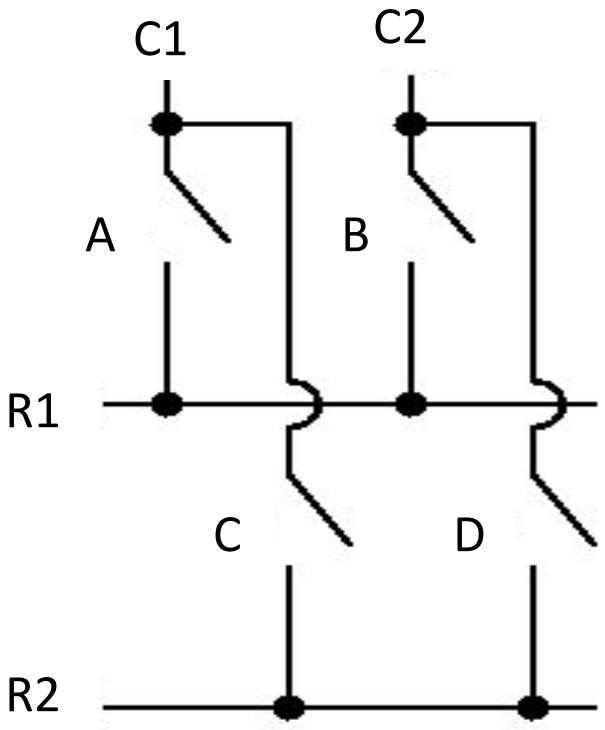
- Problem statement
  - A bank of push-button keys are connected as inputs to PORTB.
  - The pull-up resistors are internal to PORTB.
  - Write a program to recognize a key pressed, debounce the key, and identify its location in the key bank with numbers from 0 to 7.





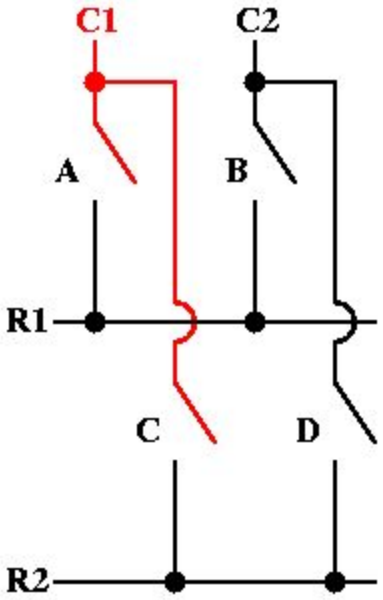
How key board works: 2D

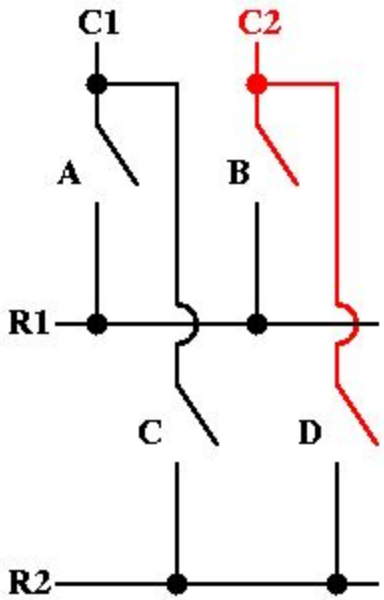




- Two dimensional
  - Scan Column for 1
  - Scan Row for 1

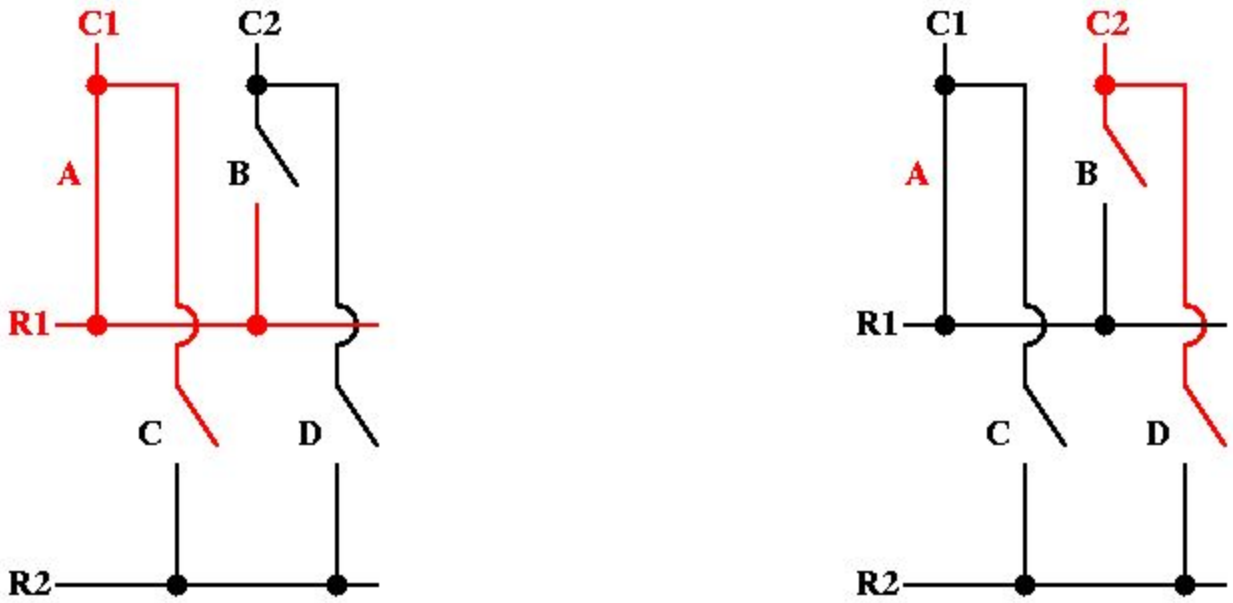
How key board works :2D





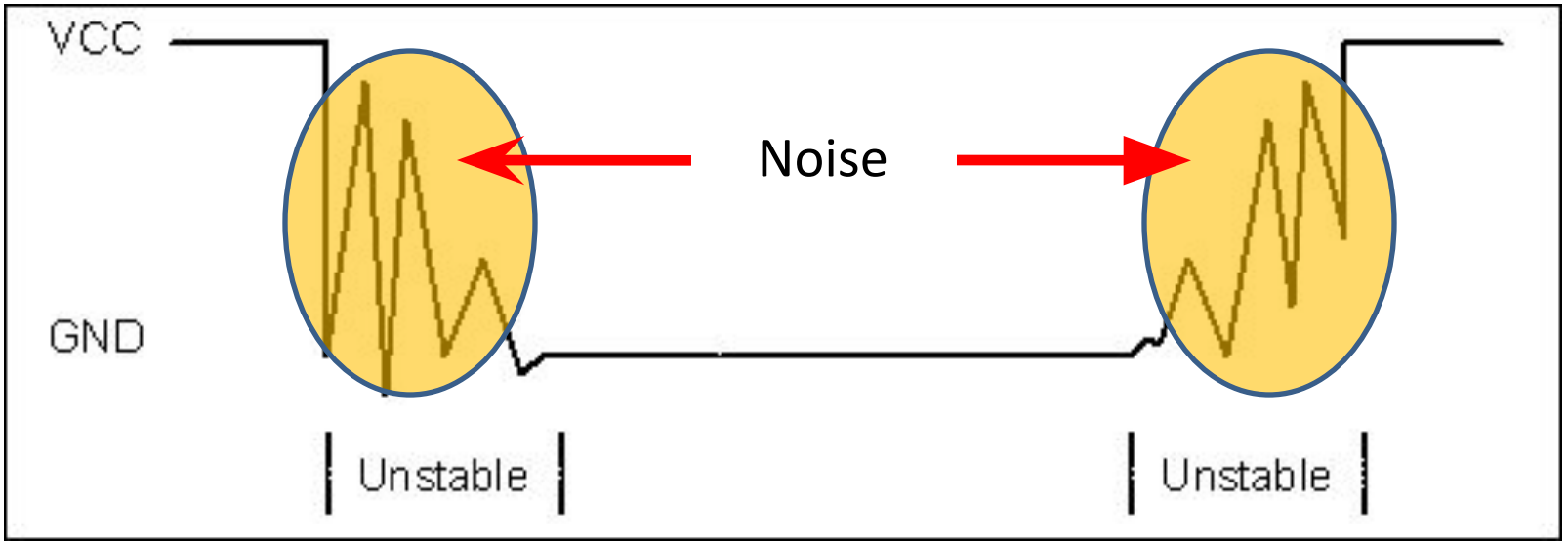
- Scan C1 & C2: found both are zero
- Scan R1 & R2: found both are zero

How key board works :2D

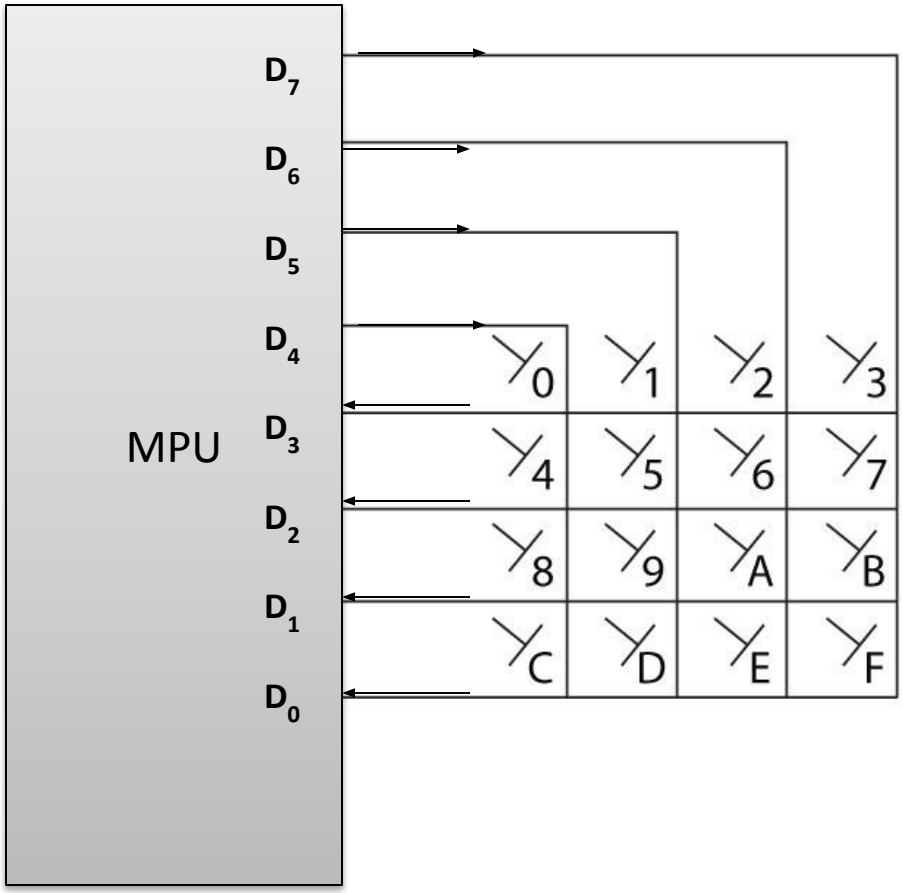


- Scan C1 & C2: found C1=1, C2=0
- Scan R1 & R2: found R1=1, R2=0
- So Key pressed: C1R1 is Key ‘A’

Keyboard Debounce



Interfacing a Matrix Keyboard



Send Data using Data BUS "D7,D6,D5,D4"

Receive data using Data BUS "D3,D2,D1,D0"

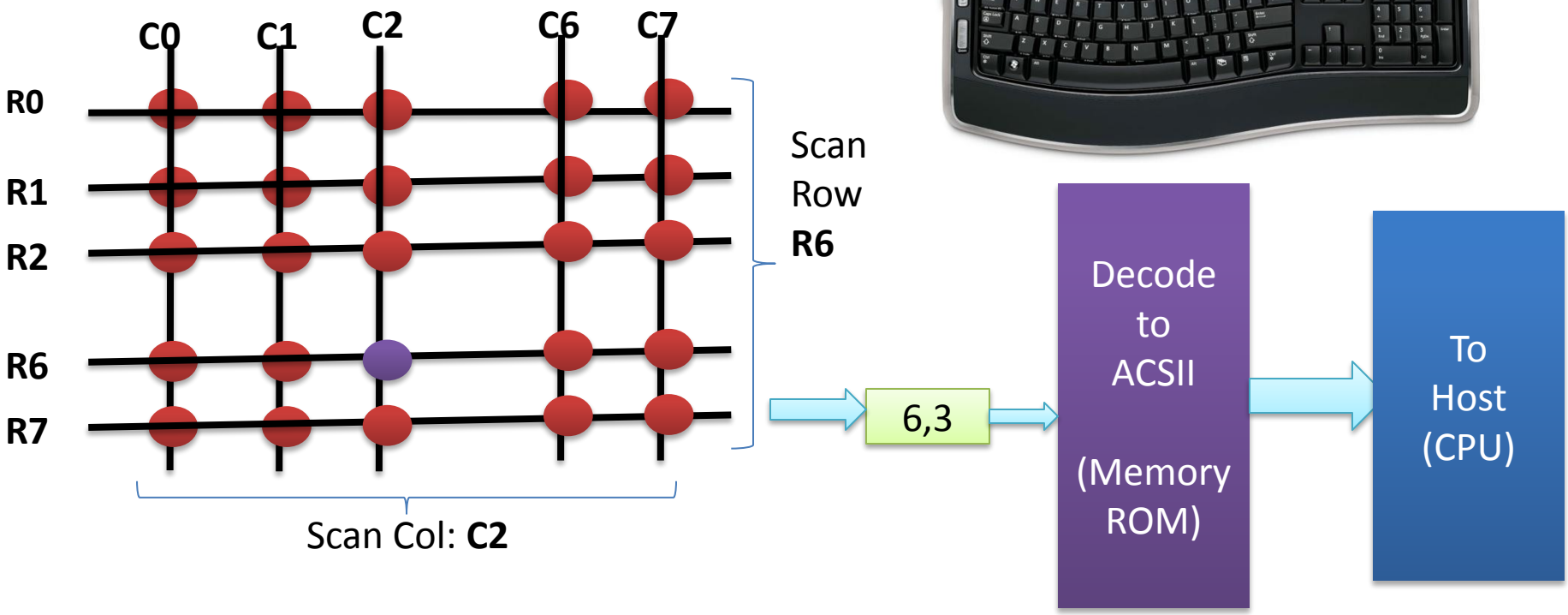
Identify the column & Row

Display the proper HEX Digit on LED display

Interfacing a Matrix Keyboard

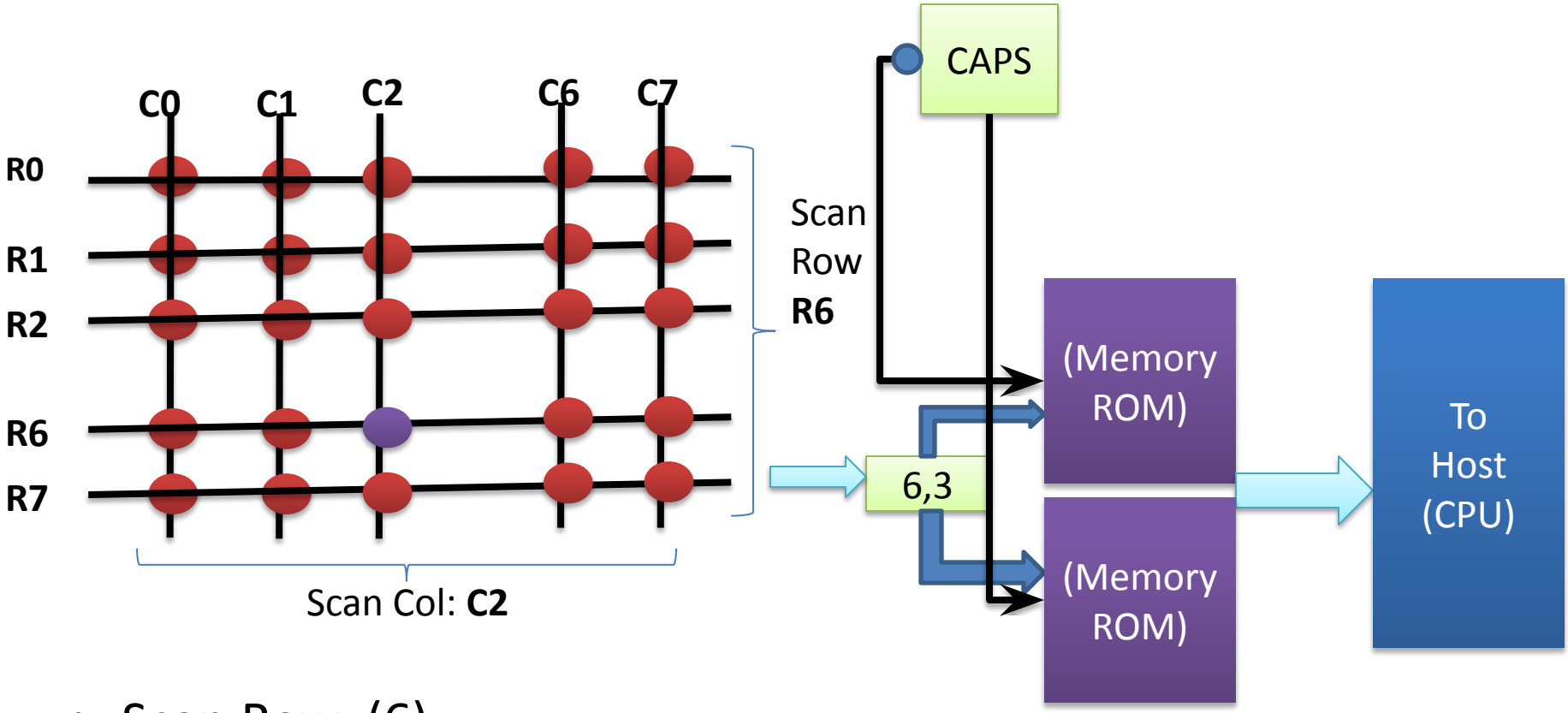
- Software
  - To recognize and encode the key pressed, the program should:
    - Ground all the columns by sending zeros.
    - Check each key in a row for logic zero.
    - Ground one column at a time and check all the rows in that column.
    - Once a key is identified, it is encoded based on its position in the column.

Simple keyboard with 64 keys



- Scan Row (6)
- Scan Column (3)
- Send this to Decoder to generate ASCII value or Scan code

Simple keyboard with 64 keys: when CAP is On

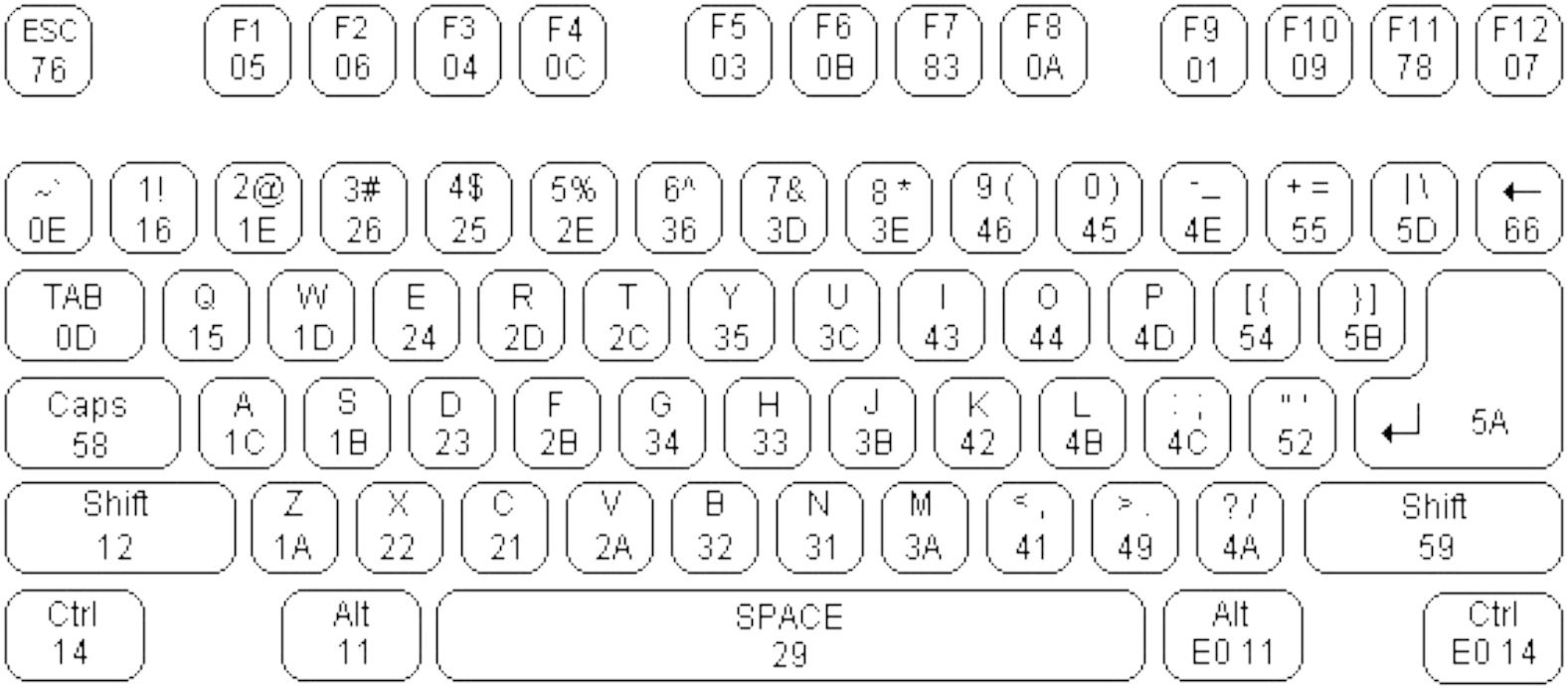


- Scan Row (6)
- Scan Column (3)
- Send this to Decoder to generate ASCII value or Scan code

Modern Keyboard

- 104 Key
- PS2 Serial interface
- Scanned code
- Scanned to ASCII by software

Keyboard scan code



Keyboard work is send the code

Software handle the rest of the work

What happens when you press a key?

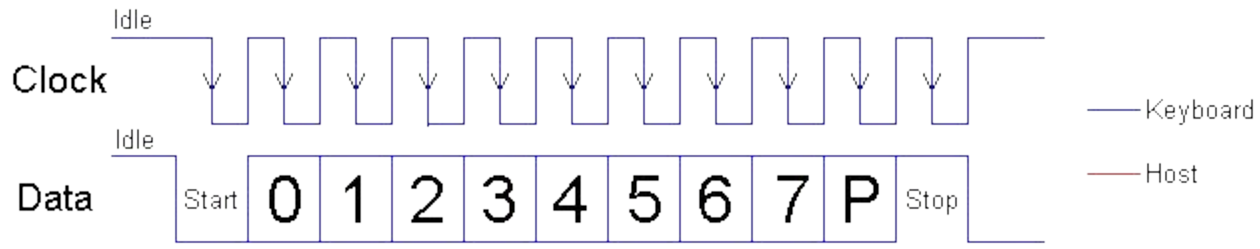
- For *most keys:*
  - Key is pressed
    - keyboard sends 8-bit scan code for that key
  - Key is released :
    - keyboard sends F0
    - keyboard sends scan code
- For extended keys:
  - Key is pressed
    - keyboard sends E0
    - may send 1 or more scan codes
  - Key is released:
    - keyboard sends E0 F0
    - keyboard sends scan code

What Sent to PC

- ASCII is not sent, Scan codes for keys
  - Least significant bit first
- Normally translated by software
  - You remap your keys, for example
  - Software takes care of Shift, caps lock, control
- Scan code generated when you press
- And when you release
  - Two bytes: F0 followed by key scan code
  - Example:
    - Space pressed, 29 sent
    - Space released, F0 29 sent
- If you hold key, scan code repeated

PS/2 Keyboard (Personal System)

- Uses a synchronous serial protocol
  - What does that mean?



Peripheral controller & Timer

- Timer
  - Many devices in system
  - MPU use many delay routines
- Interrupt controller
- Programmable Interrupt controller
  - ADC/DAC controller
  - Keyboard controller
  - Display controller

Thanks