P14: Smart Lighting System

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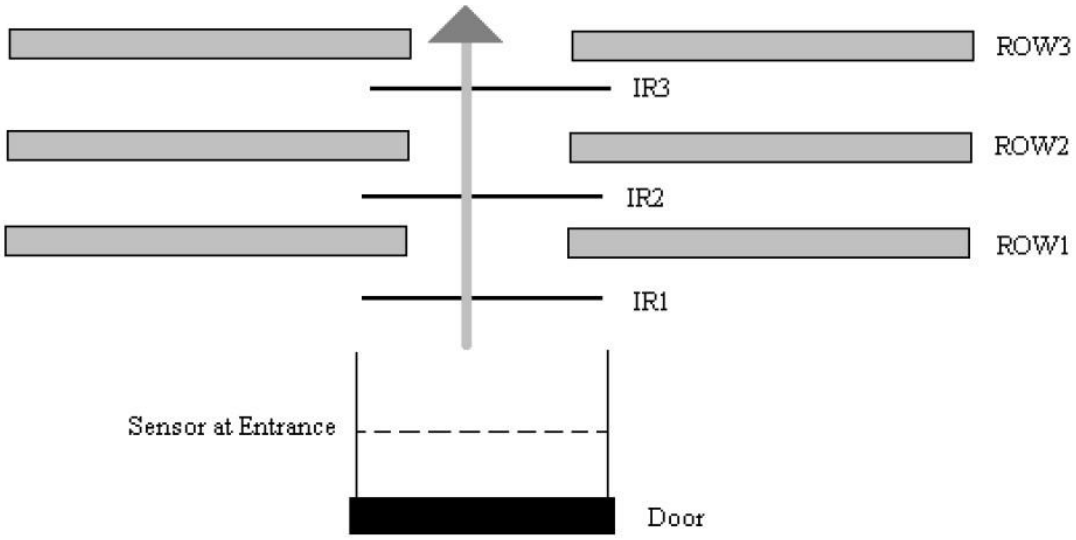
1. Design Specifications

Description: This is a lighting system for a conference room. As the seats get filled the light should be turned on. The rows are filled from row1 onwards. There are 2 lights per row. As each row begins to get filled the lights get turned on as each rows empties completely the light gets turned off. You can assume there are at least 10 rows.

System Details:

Diagram: of problem



List of inputs to system:

1xPIR Sensor at the entrance

10xPIR Sensors for the rows, 1 before each row

List of outputs:

10xRelays connected to 20 Lights

2. Assumptions made with respect to problem:

Assumptions that have been made with respect to the design problem are as follows:

- The conference room has 10 rows.
- Each row can seat a maximum of 10 people
- The room first fills up with people first occupying row 1, then row 2 and so on and then, empties out with people from the last row leaving first then last but one and finally row 1 is vacated.

3. Hardware used

A) 8086

B) PIR SENSOR

C) 8255

D) RELAYS

E) LS138

F) LS245

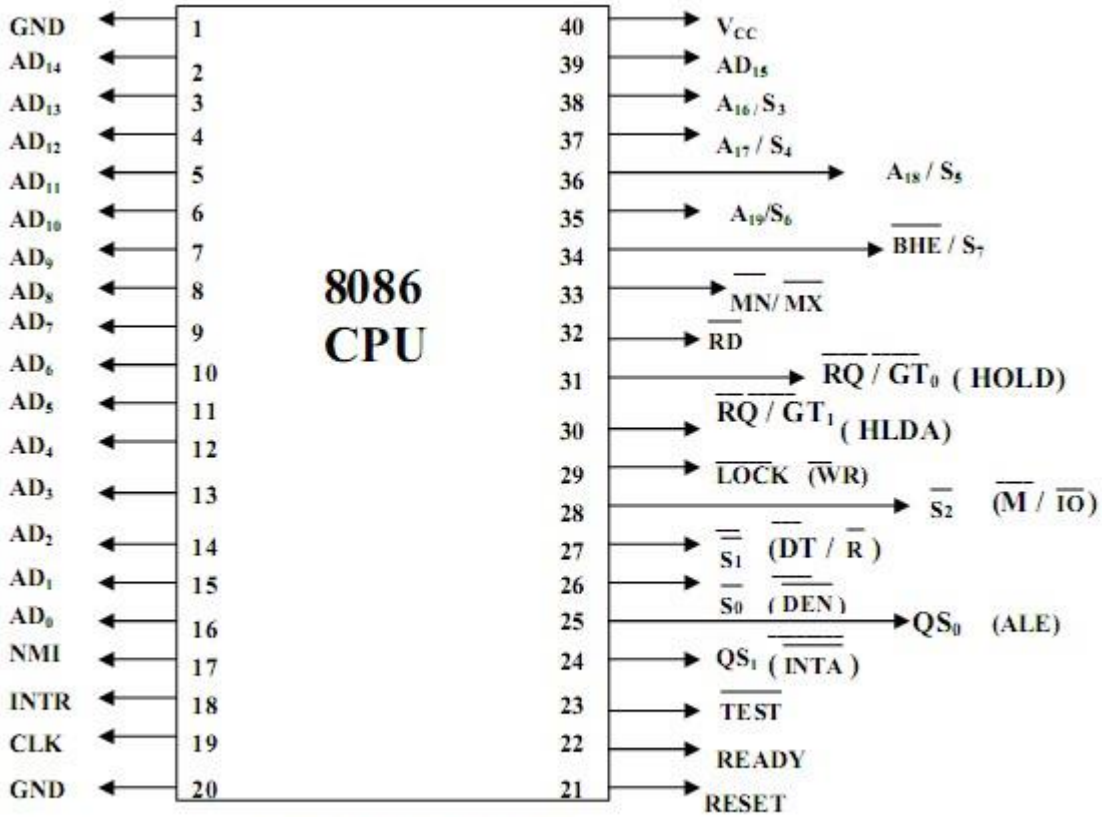
G) LS373

H) 2716

I) 2732

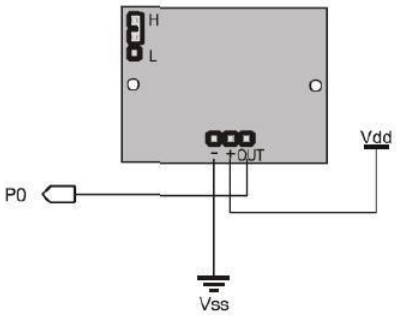
J) 6116

A) 8086 processor



Pin Diagram of 8086

B) PIR Sensor Module by Parallax Inc. #555-28027



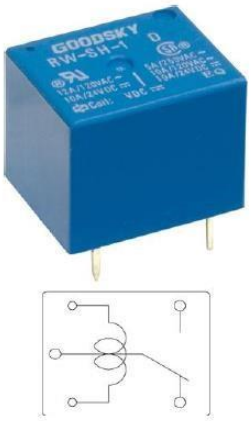
PIRs are made of a pyroelectric element, which can detect levels of ambient infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is split in two halves. If one half sees more or less IR radiation than the other, the output will swing high or low.
Along with the pyroelectic sensor is a bunch of supporting circuitry, resistors and capacitors. The module here uses the BISS0001 ("Micro Power PIR Motion Detector IC"). This chip takes the output of the sensor and does some minor processing on it to emit a digital output pulse from the analog sensor.

Pin	Name	Function
-	GND	Connects to Ground or Vss
+	V+	Connects to +5V DC or Vdd
OUT	Output	Connects to an I/O pin set to INPUT mode

- Digital pulse high (3V) when triggered (motion detected) digital low when idle (no motion detected). Pulse lengths are determined by resistors and capacitors on the PCB.
- Sensitivity range: up to 20 feet (6 meters) 110° x 70° detection range
- Power supply: 5V-9V input voltage

C) Relays:

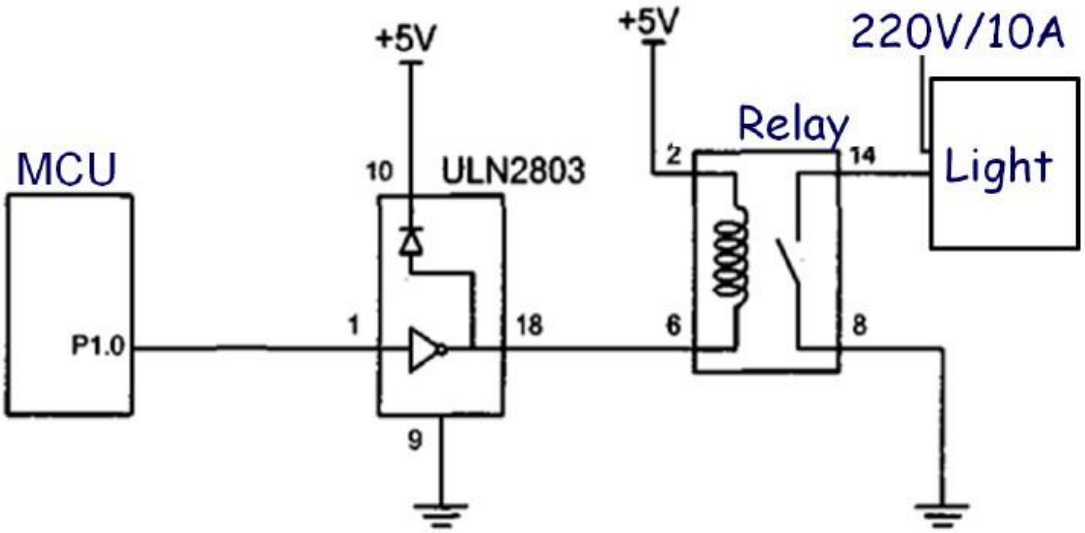
Goodsky RWH-SS-105D 5V/12A SPDT Relay



- Contact rating 15A @ 120VAC/24VC
- Maximum Voltage 240VAC/110VDC
- Minimum Switching Load 15mA @ 5VDC

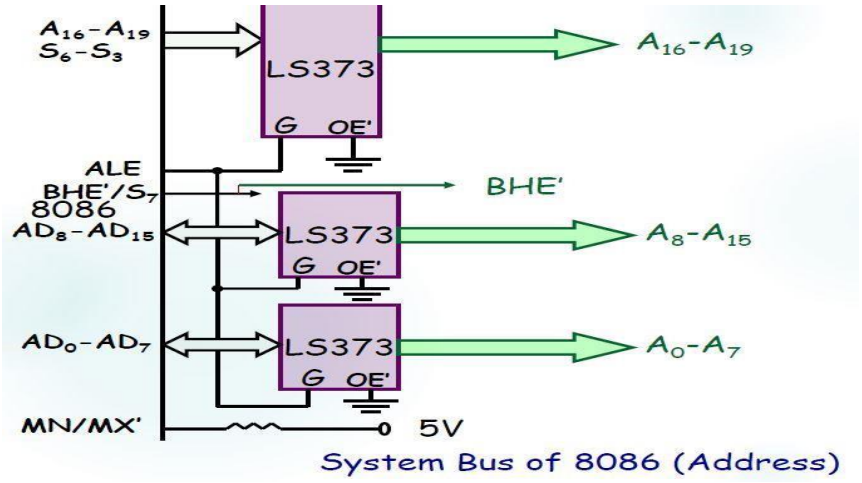
10 Relays are required to drive 20 Lights (2 for each row as given in the problem description).
In order to supply 15mA current to the relay from the MCU, ULN2803A is used

Relay driver-ULN2803A

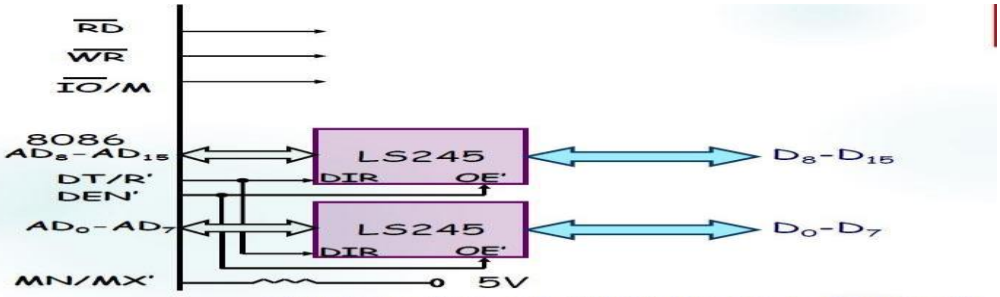


3) Parts of Circuit:

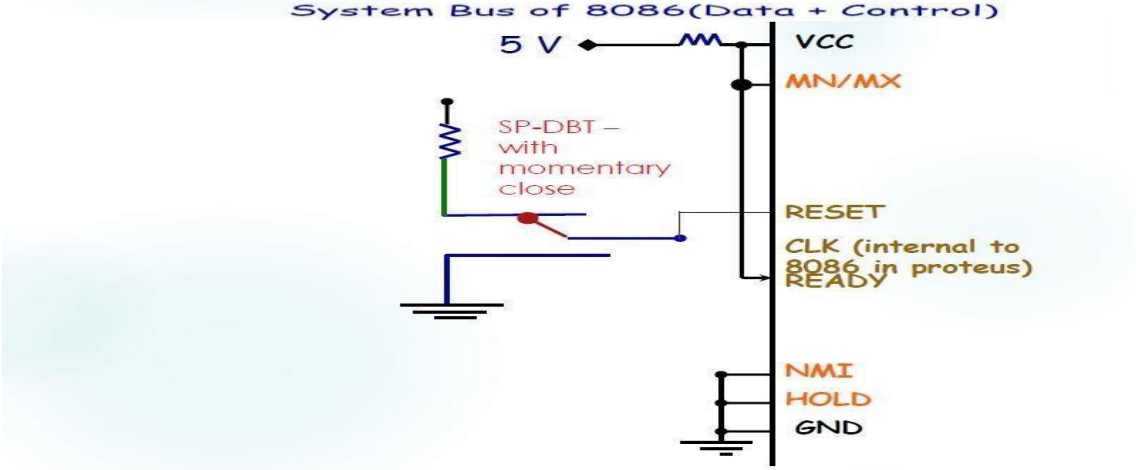
Memory Interfacing with 8086:



System Bus of 8086 (Address)



System Bus of 8086(Data + Control)

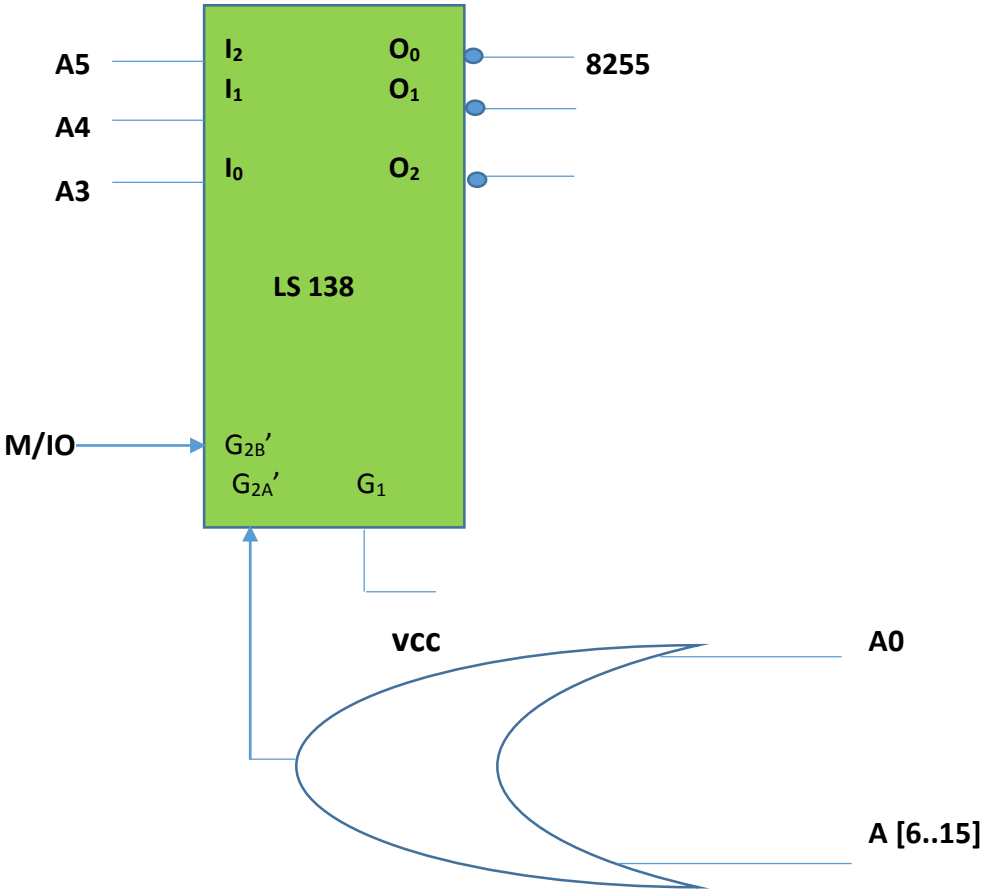


8086 Inputs

ADDRESSING 8255:

$00_h - 06_h$ 8255

Absolute addressing



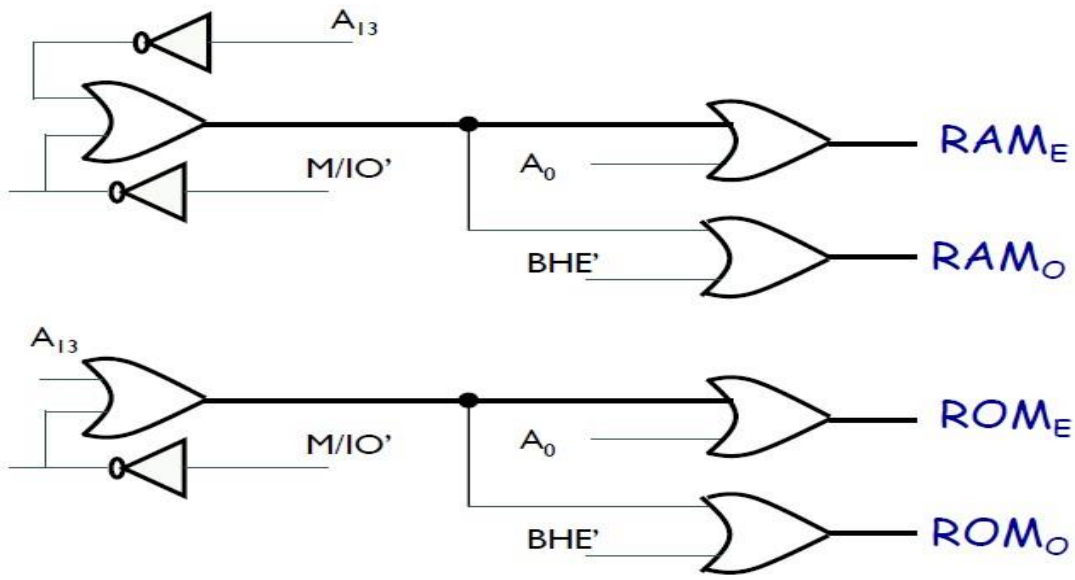
MEMORY INTERFACING

RAM – 6116 (2 chips) (RAM (Even) AND RAM (0DD))

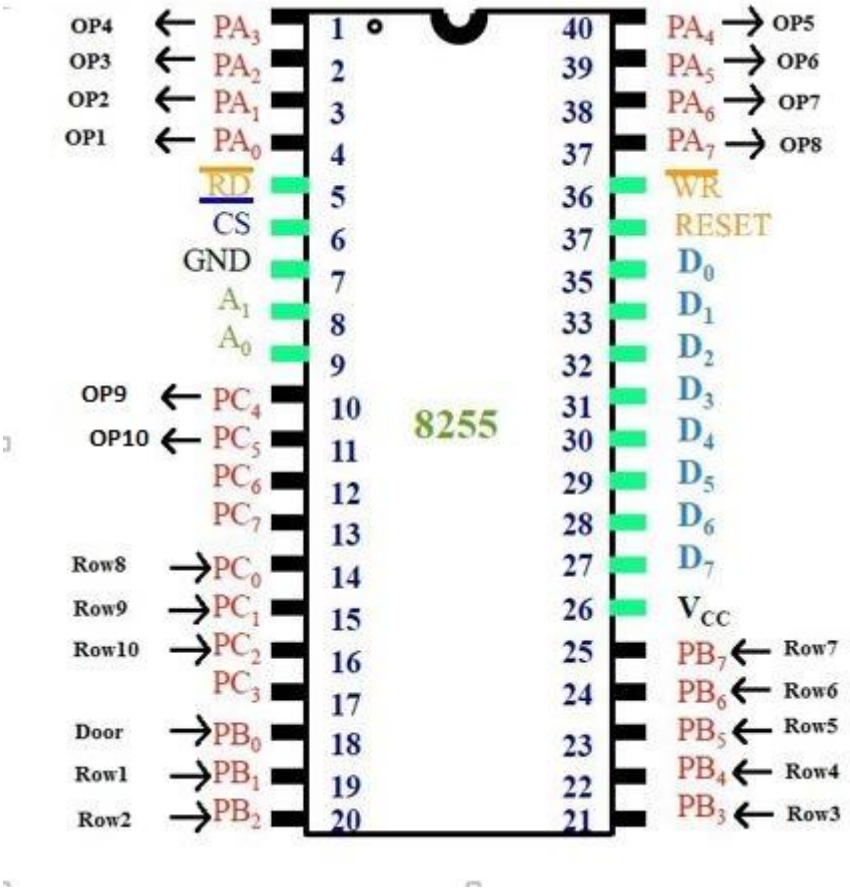
ROM – 2732(2 chips) (ROM (Even) AND ROM (ODD))

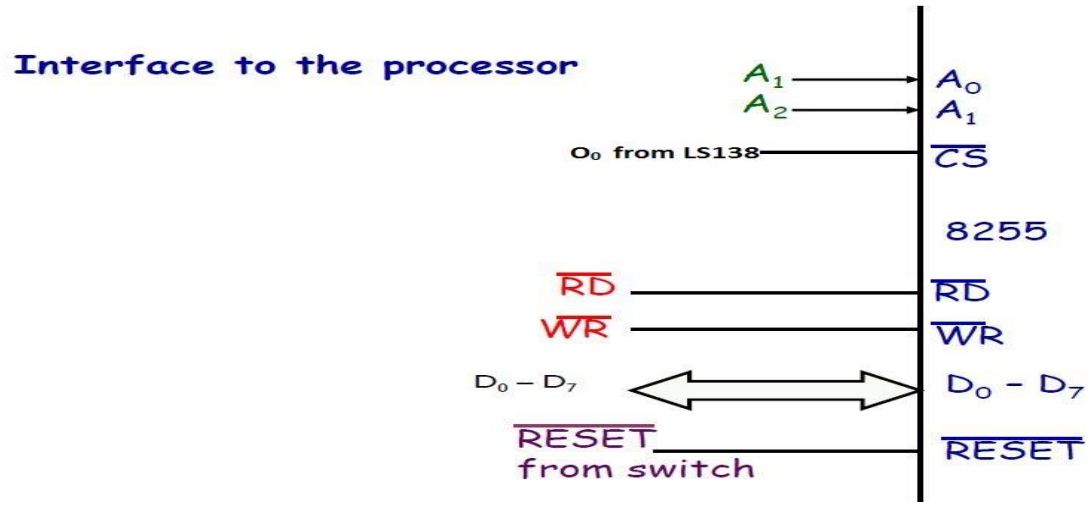
ROM 00000H - 01FFFH

RAM 02000H – 02FFFH

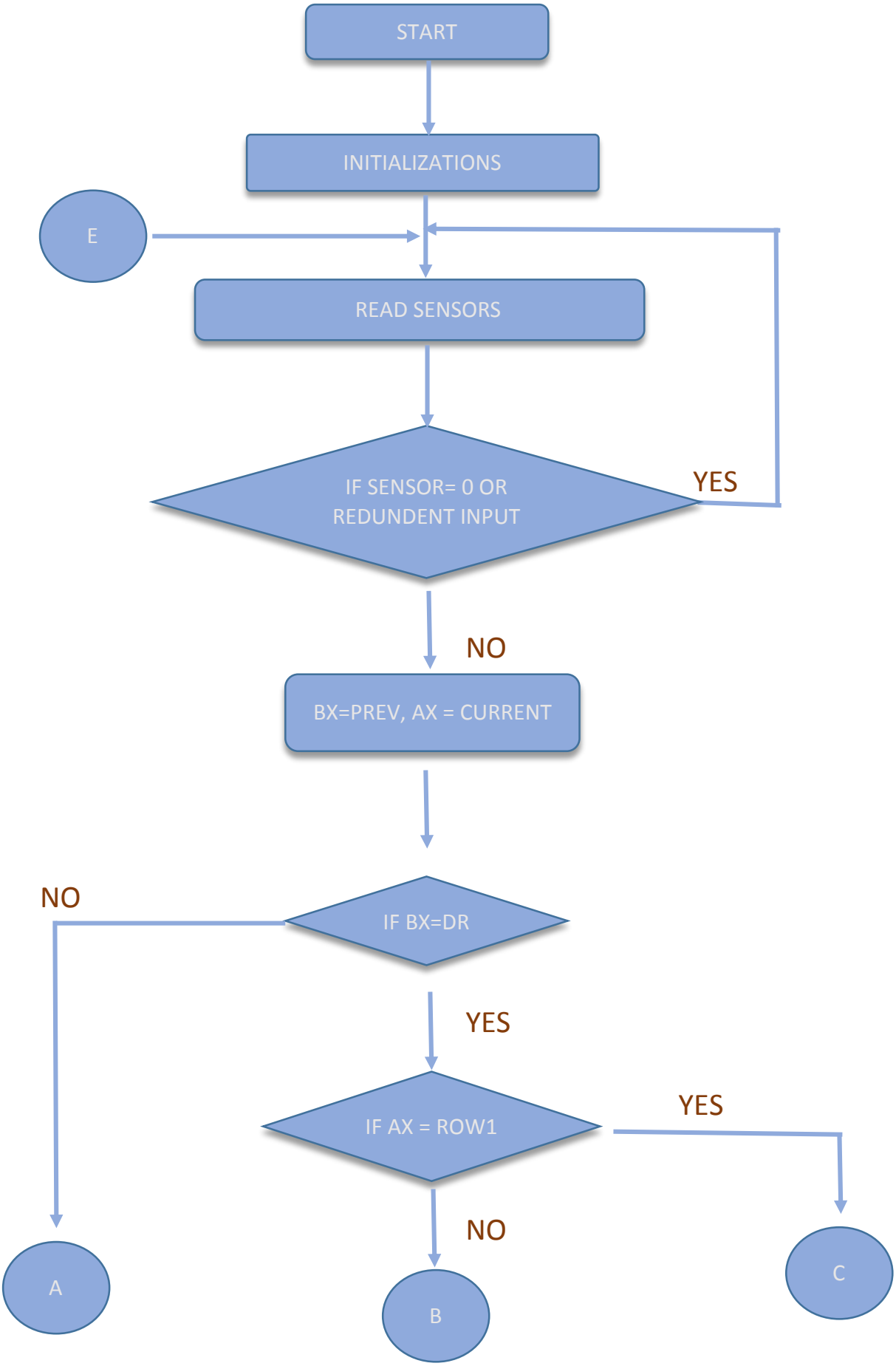


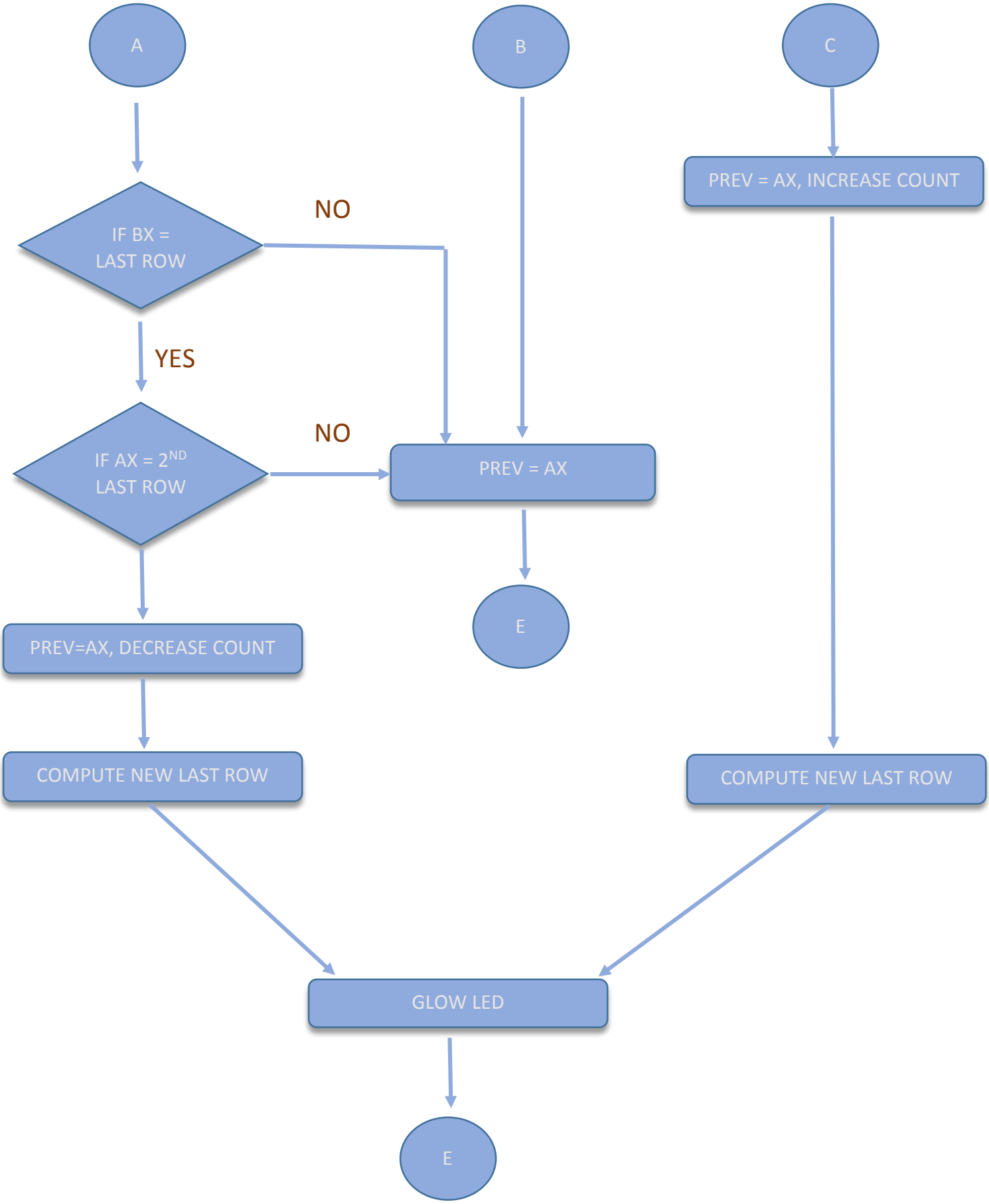
I/0 Connections of 8255:





Flowchart:


START
INITIALIZATIONS
E
READ SENSORS
IF SENSOR= 0 OR
REDUNDENT INPUT
YES
NO
BX=PREV, AX = CURRENT
NO
IF BX=DR
YES
IF AX = ROW1
YES
NO
A
B
C


A
B
C
IF BX = LAST ROW
NO
YES
PREV = AX, INCREASE COUNT
IF AX = 2ND LAST ROW
NO
PREV = AX
E
PREV=AX, DECREASE COUNT
COMPUTE NEW LAST ROW
COMPUTE NEW LAST ROW
GLOW LED
E

Code:

```
#make_bin#

#LOAD_SEGMENT=FFFFh#
#LOAD_OFFSET=0000h#

#CS=0000h#
#IP=1000h#

#DS=0000h#
#ES=0000h#

#SS=0000h#
#SP=FFFEh#


#AX=0000h#
#BX=0000h#
#CX=0000h#
#DX=0000h#
#SI=0000h#
#DI=0000h#
#BP=0000h#

      jmp     st1
      db     507 dup(0)


      dw     0000
       db      508 dup(0)
      count         equ   28h
      prev  equ   20h   ;variable initialization
```

```
        curr   equ   24h
        led    equ   26h
        last   equ   30h
        creg   equ   06h
        porta        equ   00h
        portb        equ   02h
        portc equ   04h


st1:     cli
; intialize ds, es,ss to start of RAM
        mov      ax,0200h
        mov      ds,ax
        mov      es,ax
        mov      ss,ax
        mov      sp,0FFFEH

        mov si,prev
        mov [si],00h
        mov [si+1],00h

     mov si,count
     mov [si],00h

          mov si,last
          mov [si],01h

;intialize porta, portc_upper as output, portb, portc_lower as input
        mov al,10000011b      ;mode input output initialization 8255
          out creg,al

;check switch input and display switch no.
x1:    in al, portc
```

```
        mov ah,al
        in al, portb
        and ah, 07h
;   mov ax,0002h
        mov [curr],ax

        cmp ax,0000h
        jz x1
        mov si,prev
        cmp ax,[si]
        jz x1



        mov si,prev
        mov bx,[si]

        cmp bx,0001h    ;check prev = door
        jnz cklast

        cmp ax,0002h    ;check curr = row1
        jz incre

        jmp output

cklast:     mov si,last
        cmp [si],01h
        jz output

        mov si,last
        mov cx,[si]
        mov dx,01h

index:  rol dx,1
```

```
        loop index

        cmp bx,dx
        jnz output

        ror dx,1
        cmp ax,dx
        jz decre

        jmp output

incre:  mov [prev],ax

        mov si,count
        inc [si]

        mov ax,[si]
        mov cl, 3
        div cl
        mov [last],al

        cmp ah,0
        jz getled
        inc [last]
        mov si,last
        mov dx,[si]

        jmp getled

decre:  mov [prev],ax

        mov si,count
        dec [si]
```

```
        mov ax,[si]

        mov cl,3
        div cl
        mov [last],al

        cmp ah,0
        jz getled
        inc [last]

        jmp getled

output:     mov [prev],ax
        jmp x1


getled:     mov dx,1
        mov si,last
        mov cx,[si]
        mov [led],0000h

gogo:       mov si,led
        or [si],dx
        rol dx,1
        loop gogo

        mov si,led
        mov ax,[si]
        out porta,al
        rol ah,4
        and ah,30h
        mov al,ah
```

```
        out portc,al

jmp x1
;check switch input and display switch no.
```

Datasheets:

1) PIR Sensors

PIR Sensor (#555-28027)

The PIR (Passive Infra-Red) Sensor is a pyroelectric device that detects motion by sensing changes in the infrared (radiant heat) levels emitted by surrounding objects. This motion can be detected by checking for a sudden change in the surrounding IR pattern. When motion is detected the PIR sensor outputs a high signal on its output pin. This logic signal can be read by a microcontroller or used to drive an external load; see the source current limits in the features list below.

NOTE: Revision B of this sensor provides many updates and improvements from Revision A. If your PIR Sensor's PCB does not read "Rev B," please use the information found in the Revision History section on page 5.

Features

- Detect a person up to approximately 30 ft away, or up to 15 ft away in reduced sensitivity mode
- Jumper selects normal operation or reduced sensitivity
- Source current up to 12 mA @ 3 V, 23 mA @ 5 V
- Onboard LEDs light up the lens for fast visual feedback when movement is detected
- Mounting holes for #2 sized screws
- 3-pin SIP header ready for breadboard or through-hole projects
- Small size makes it easy to conceal
- Easy interface to any microcontroller

Key Specifications

- Power Requirements: 3 to 6 VDC; 130 µA idle, 3 mA active (no load)
- Communication: Single bit high/low output
- Operating temperature: 32 to 122 °F (0 to 50 °C)
- Dimensions: 1.41 x 1.0 x 0.8 in (35.8 x 25.4 x 20.3 cm)

Application Ideas

- Motion-activated nightlight
- Alarm systems
- Holiday animated props

Revision History

The information that follows contains revision history for the PIR documentation.

V 2.0: PIR Sensor Rev A

Both revisions of this sensor use the same Fresnel lens, and basic functionality remains the same between the two (for example you can use the same test programs). However, there were a number of improvements and updates made to Revision B, and if using Revision A in your project the following information should be noted and used.

Features

- Detection range up to 20 feet away
- Single bit output
- Jumper selects single or continuous trigger output mode
- 3-pin SIP header ready for breadboard or through-hole project
- Small size makes it easy to conceal
- Compatible with BASIC Stamp, Propeller, and many other microcontrollers

Key Specifications

- Power Requirements: 3.3 to 5 VDC; >3 mA **(may vary)**
- Communication: Single bit high/low output
- Operating temperature: 32 to 122 °F (0 to 50 °C)
- Dimensions: 1.27 x 0.96 x 1.0 in (32.2 x 24.3 x 25.4 mm)

Key Differences

- Jumper setting controls triggering and not distance
- Driving an external load requires a transistor or MOSFET
- Detection range up to 20 ft away

Pin Definitions and Ratings

Pin	Name	Function
-	GND	Ground: 0 V
+	Vin	Supply Voltage: 3 to 6 VDC
OUT	Output	Connect to I/O pin set to INPUT mode (or transistor/MOSFET).

Jumper Settings

Symbol	Description
H	Output remains HIGH when sensor is retriggered repeatedly. Output is LOW when idle (not triggered).
L	Output goes HIGH then LOW when triggered. Continues motion results in repeated HIGH/LOW pulses. Output is LOW when idle.

V 2.1: The explanation of the sensitivity jumper setting have been updated throughout, and the Range section, including a temperature vs. range graph, were added.
V 2.1: Added information for load current to Features and Specifications.

2) 8255

intel

82C55A
CHMOS PROGRAMMABLE PERIPHERAL INTERFACE

- Compatible with all Intel and Most Other Microprocessors
- High Speed, "Zero Wait State" Operation with 8 MHz 8086/88 and 80186/188
- 24 Programmable I/O Pins
- Low Power CHMOS
- Completely TTL Compatible
- Control Word Read-Back Capability
- Direct Bit Set/Reset Capability
- 2.5 mA DC Drive Capability on all I/O Port Outputs
- Available in 40-Pin DIP and 44-Pin PLCC
- Available in EXPRESS
  - —Standard Temperature Range
  - —Extended Temperature Range

The Intel 82C55A is a high-performance, CHMOS version of the industry standard 8255A general purpose programmable I/O device which is designed for use with all Intel and most other microprocessors. It provides 24 I/O pins which may be individually programmed in 2 groups of 12 and used in 3 major modes of operation. The 82C55A is pin compatible with the NMOS 8255A and 8255A-5.

In MODE 0, each group of 12 I/O pins may be programmed in sets of 4 and 8 to be inputs or outputs. In MODE 1, each group may be programmed to have 8 lines of input or output. 3 of the remaining 4 pins are used for handshaking and interrupt control signals. MODE 2 is a strobed bi-directional bus configuration.

The 82C55A is fabricated on Intel's advanced CHMOS III technology which provides low power consumption with performance equal to or greater than the equivalent NMOS product. The 82C55A is available in 40-pin DIP and 44-pin plastic leaded chip carrier (PLCC) packages.

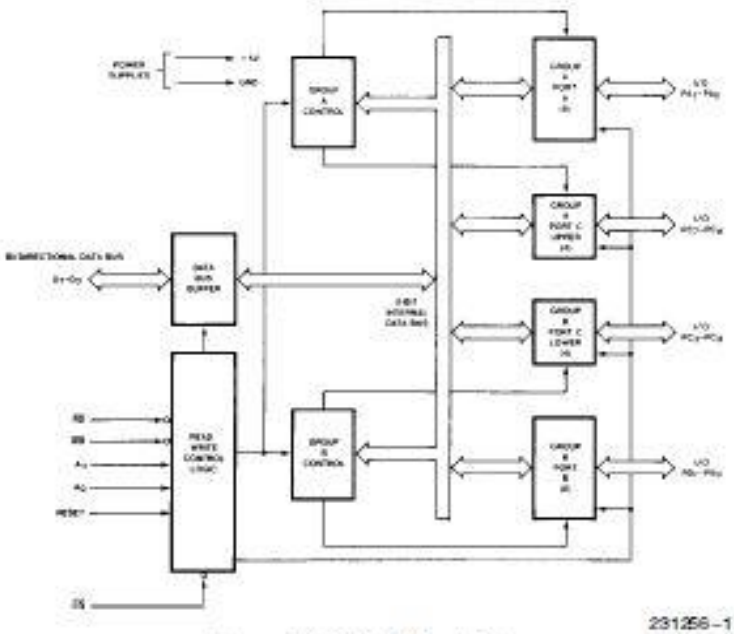


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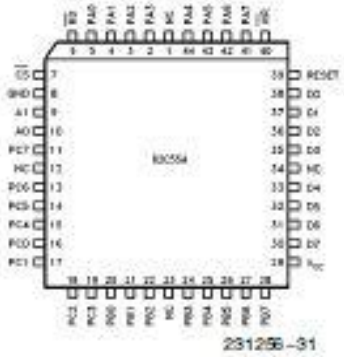
Figure 1. 82C55A Block Diagram



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231256-2

Table 1. Pin Description

Symbol	Pin Number Dip	Pin Number PLCC	Type	Name and Function
PA_{3-0}	1–4	2–5	I/O	**PORT A, PINS 0–3:** Lower nibble of an 8-bit data output latch/ buffer and an 8-bit data input latch.
$\overline{RD}$	5	6	I	**READ CONTROL:** This input is low during CPU read operations.
$\overline{CS}$	6	7	I	**CHIP SELECT:** A low on this input enables the 82C55A to respond to $\overline{RD}$ and $\overline{WR}$ signals. $\overline{RD}$ and WR are ignored otherwise.
GND	7	8		**System Ground**
A_{1-0}	8–9	9–10	I	**ADDRESS:** These input signals, in conjunction $\overline{RD}$ and $\overline{WR}$, control the selection of one of the three ports or the control word registers.

A_1	A_0	$\overline{RD}$	$\overline{WR}$	$\overline{CS}$	Input Operation (Read)
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
1	1	0	1	0	Control Word - Data Bus
					Output Operation (Write)
0	0	1	0	0	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
					Disable Function
X	X	X	X	1	Data Bus - 3 - State
X	X	1	1	0	Data Bus - 3 - State

PC_{7-4}	10–13	11,13–15	I/O	**PORT C, PINS 4–7:** Upper nibble of an 8-bit data output latch/ buffer and an 8-bit data input buffer (no latch for input). This port can be divided into two 4-bit ports under the mode control. Each 4-bit port contains a 4-bit latch and it can be used for the control signal outputs and status signal inputs in conjunction with ports A and B.
PC_{0-3}	14–17	16–19	I/O	**PORT C, PINS 0–3:** Lower nibble of Port C.
PB_{0-7}	18–25	20–22, 24–28	I/O	**PORT B, PINS 0–7:** An 8-bit data output latch/buffer and an 8-bit data input buffer.
V_{CC}	26	29		**SYSTEM POWER:** + 5V Power Supply.
D_{7-0}	27–34	30–33, 35–38	I/O	**DATA BUS:** Bi-directional, tri-state data bus lines, connected to system data bus.
RESET	35	39	I	**RESET:** A high on this input clears the control register and all ports are set to the input mode.
$\overline{WR}$	36	40	I	**WRITE CONTROL:** This input is low during CPU write operations.
PA_{7-4}	37–40	41–44	I/O	**PORT A, PINS 4–7:** Upper nibble of an 8-bit data output latch/ buffer and an 8-bit data input latch.
NC		1, 12, 23, 34		No Connect

3) 2732

F2732
32K (4K x 8)
UV Erasable PROM

MOS Memory Products

Description

The F2732 is a 32,768-bit ultraviolet light Erasable and electrically Programmable Read Only Memory (EPROM) manufactured using the Isoplanar n-channel silicon gate technology. Organized 4096 X 8, the F2732 is ideally suited for non-volatile data storage in applications such as 8-bit microprocessor systems, where reprogrammability, high bit-density, maximum performance, and simple interfacing are essential parameters. All inputs and outputs are TTL-compatible. The 3-state outputs become high impedance when the F2732 is deselected, allowing a direct interface capability which is useful in many computer bus structures.

The F2732 operates from a single standard +5 V power supply during reading, making it compatible with the latest generations of microprocessors.

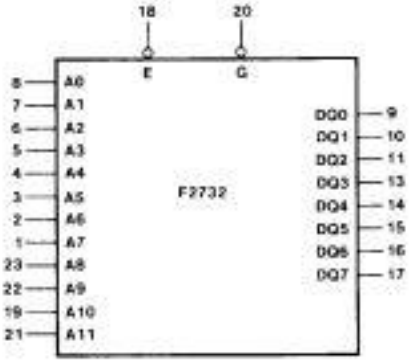
The F2732 programming technique is the simplest available. All data and address inputs are at TTL levels during programming. A +25 V power supply is connected to the $\overline{G}$/VPP pin and only those addresses to be programmed need be selected; therefore total programming time is short and field corrections straight forward. The technique is compatible with board-level programming making large systems simple to program.

- **4096 x 8-BIT ORGANIZATION**
- **FAST ACCESS TIME—450 ns MAX**
- **TTL-COMPATIBLE INPUTS AND OUTPUTS**
- **3-STATE OUTPUTS FOR WIRED-OR CAPABILITY**
- **SINGLE +5 V POWER SUPPLY FOR READ OPERATION**
- **REDUCED POWER STANDBY MODE**
- **SIMPLEST, FASTEST EPROM PROGRAMMING TECHNIQUE AVAILABLE**
- **OUTPUT ENABLE CONTROL FOR MEMORY EXPANSION**
- **STATIC OPERATION**
- **PIN COMPATIBLE WITH 32K AND 64K ROMs FOR LOW COST PRODUCTION**
- **LOW POWER DURING PROGRAMMING**
- **CONTENTS ERASABLE WITH ULTRAVIOLET LIGHT**

Pin Names

A0-A11	Address Inputs
$\overline{E}$	Chip Enable (Power Down) Input
$\overline{G}$/VPP	Output Enable/+25 V Program Input
DQ0-DQ7	Data Output/Programming Inputs
VCC	+5 V Supply
VSS	Ground

Logic Symbol



VCC = Pin 24
VPP = Pin 20
VSS = Pin 12

Connection Diagram
24-Pin DIP

(Top View)

Package	Outline	Order Code
Ceramic DIP	7W	D

Absolute Maximum Ratings

VCC Supply Voltage	−0.3 V to +6 V
Any Input or Output	−0.3 V to +6 V
Operating Temperature (Ambient)	0°C to 70°C
Storage Temperature (Ambient)	−65°C to + 125°C

All voltages with respect to VSS.
Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions exceeding those indicated in the operational sections of these specifications is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect device reliability.

Block Diagram