Birla Institute of Technology & Science, Pilani
K K Birla Goa Campus

Report on

MINE EXPLORATION VEHICLE

BATCH NUMBER: 76
QUESTION NUMBER: 31

Submitted by:

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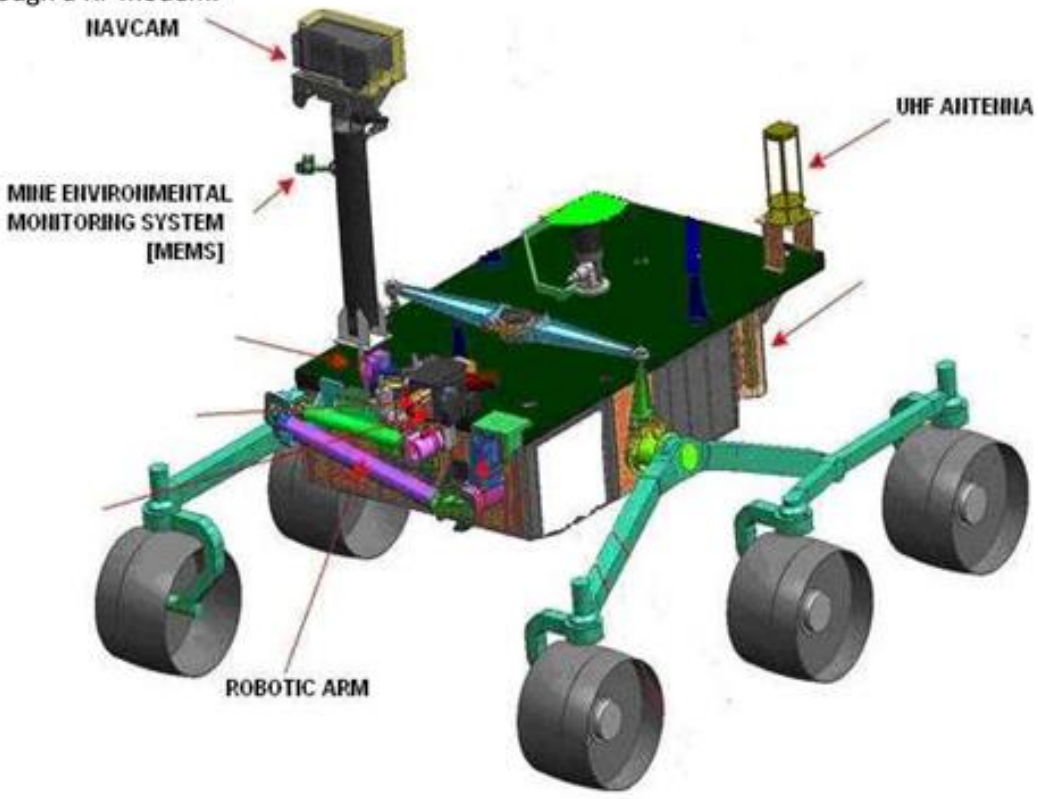
Problem Statement:

P31: Mine Exploration Vehicle

A Mine Exploration Vehicle (MEV) is to be designed. The vehicle is six-wheeled with an on-board robotic arm to pick up samples and on-board scientific instruments and cameras (vehicle fig is shown below). The primary aim of the vehicle is to explore the terrain, measure atmospheric conditions in the mine and assess samples of rocks and soil. This can be controlled remotely from above the ground. All subsystems on the vehicle are controlled by the remote unit and are in contact with the remote unit through a RF modem.



Vehicular motion and Sample collection Subsystem

Each of the six wheels is to be powered by an individual motor so that the vehicle is capable of climbing over obstacles not exceeding a certain height. The vehicle can execute a 360° turn in-place. The front and rear wheels are used for steering. An upright position is to be maintained at all times and hence the suspension of the vehicle cannot have a tilt > 45°. The tilt is usually not allowed to exceed 30° during normal operation.

The vehicle should be capable of digging up to small depths. Digging is to be accomplished by spinning one of the front wheels in place to grind into the soil. The same mechanism that is used for tilting the vehicle upwards is also used for tilting the vehicle downwards. The vehicle is designed to remain motionless while the digging wheel is spinning.

DC motors are used for rotating the wheels and stepper motors are used for steering. The two front wheels are locked together by the same steering mechanism; the same is done in case of the rear wheels.

A Robotic arm is used for sample collection. The robotic arm is capable of movement both in the horizontal plane and in the vertical plane.

Communication of vehicle with surface takes place through RF modem (CC2420).

DESIGN SPECIFICATIONS

Mine Exploration Vehicle is a six wheeled rover with a robotic arm designed to pick up samples and examine using on board scientific instruments and cameras.

The following are the design solution to the given problem:

- Each of the 6 wheels are powered by DC motors.

- 2 Stepper motors are used for the steering system. Stepper motor can be attached to the shaft connecting the two front wheels with the help of the rack and pinion steering mechanism, thus requiring one stepper motor each for the front wheels and rear wheels. This also locks the front wheels and the rear wheels as mentioned in the problem statement.

- This steering system enables the vehicle to climb over obstacles up to a certain height. A tilt of the vehicle is not allowed to exceed 45 degrees. This is ensured using a gyroscope. As soon as the gyroscope records a tilt of 45 degrees of greater, the motor functions are stopped.

- The digging of the test surface can also be done by moving only the front wheel. The vehicle is motionless during the digging process.

- The sample of the soil can be examined using the robotic arm. The robotic arm has 2 dc-motors, each in the vertical and the horizontal plane.

- The communication with the vehicle takes place through wired keypad which is used by the person on the surface operating the vehicle.

- 360^0 spin in place is done by rotating the left wheels forward and right wheels backward. This is using the differential drive system.

ASSUMPTIONS

The following assumptions have been made in designing:

The clock frequency is assumed to be given as 2.0MHz.

.Due to the non-availability of RF modem (CC2420) in proteus, wired transmission via the keypad on the vehicle has been used to drive the Mine Exploration Vehicle (MEV).

Gyroscope is used to measure the tilt angle which needs to be less than 45° according to the problem. Since the gyroscope is not available in the proteus library, it is simulated via a potentiometer. The analog output of gyroscope is simulated using potentiometer.

HARDWARE SPECIFICATIONS

Serial Number	Hardware	Type	Number Used
1	Microprocessor	Intel 8086	1
2	Octal Latch	74LS373	3
3	Bi-Directional Buffer	74LS245	2
4	Erasable Programmable Read Only Memory	2732 (4kx8)	2
5	Random Access Memory	6116 (2kx8)	2
6	Programmable Peripheral Interface	Intel 8255A	2
7	Logic Gates	TTL ICs	Multiple
8	DC Motor		8
9	Unipolar Stepper Motor		2
10	Pull Up Resistor		4
11	Keypad Phone		1
12	Analog to Digital Converter	ADC0804	1
13	3*8 Decoder	74LS138	1
14	Push/Pull Four Channel Motor Driver	L293D	4
15	High voltage/High Current Darlington Transistor Array	ULN2003A	1

SYSTEM DESCRIPTION

- The microprocessor based system which is able to move, explore and pick up things on being ordered using an Intel 8086 microprocessor interfaced at 2MHz as a Central Processing Unit (CPU).

- Two 4KB EPROM and two 2KB RAM are interfaced to the microprocessor.

- The system uses three 74LS373 latches for de-multiplexing address-data lines, two 74LS245 bi directional buffers to buffer data lines and one 3*8 74LS138 Decoder for selecting either of the two PPI 8255A.

First 8255A PPI

- It is used in simple I/O mode (D7 bit of 8255A is equal to 1) for interfacing keypad.
- Port A is used as an input port (MODE 00) but it is left unused.

- Port B is used as an input port (MODE 00) which takes in the input from the ADC0804.
- Port C Lower is used as input for the keys coming from keypad while Port C Upper is used as an output port.

Second 8255A PPI

- It is used in simple I/O mode (D7 bit of 8255A is equal to 1) for interfacing DC motors and Stepper Motors.
- In port A, PA0 – PA3 are used as output ports for interfacing the front wheels of vehicle while PA4 – PA7 are used as output ports for interfacing the middle two wheels of the vehicle.
- In port B, PB0 – PB3 are used as output ports for interfacing rear two wheels of the vehicle and PB4 – PB7 are used as output ports for interfacing the two stepper motors.
- Port C lower is used as an output port for interfacing two DC motors used as Robotic Arm while Port C upper is unused.

Input:

Phone keypad input is used for manually entering various commands for the vehicle.

Output:

Depending on various inputs provided by the user via the keypad, the vehicle executes the user defined task with the help of various DC motors and Stepper motors.

Functioning:

Vehicle is controlled using the keypad. When a particular key is pressed, the corresponding function is initiated and the vehicle performs that function. Following functions with their key numbers are given in the table below:

Key	Function
1	Stop the vehicle
2	Move forward
3	Dig the Soil (Using front Right Wheel)
4	Move Left
5	In-place 360^0 spin
6	Move Right
7	Move Arm Horizontally Right
8	Move reverse (Back)
9	Move Arm vertically up
0	Unused
*	Move Arm Horizontally Left
#	Move Arm Vertically Down

The vehicle can move in all directions and simultaneously move its hand in both vertical and horizontal dimensions. It also checks its tilt angle and if it is greater than 45°, it is stopped.

LIST OF THE CHIPS USED AND ADDRESS MAP

- INTEL 8086.

- PPI 8255A-1

Port A	00h
Port B	02h
Port C	04h
Control Register	06h

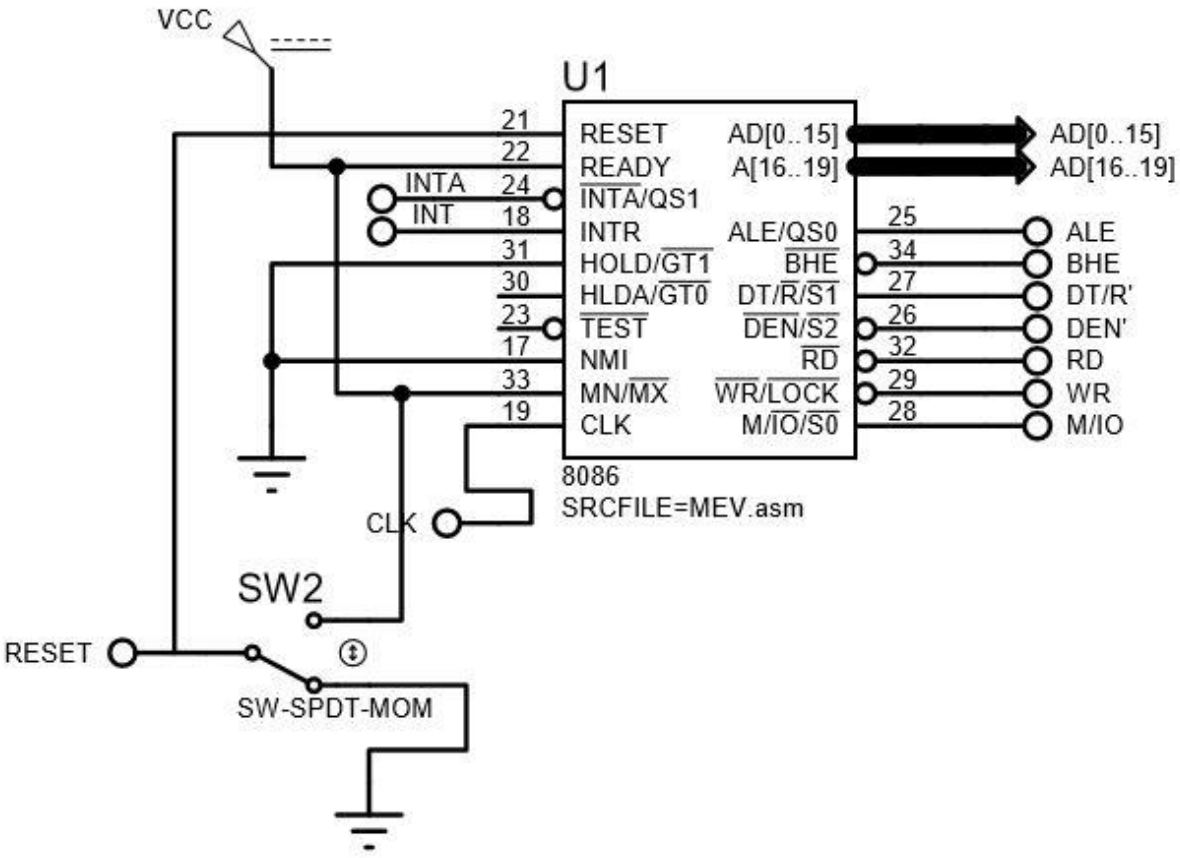
- PPI 8255A-2

Port A	08h
Port B	0Ah
Port C	0Ch
Control Register	0Eh

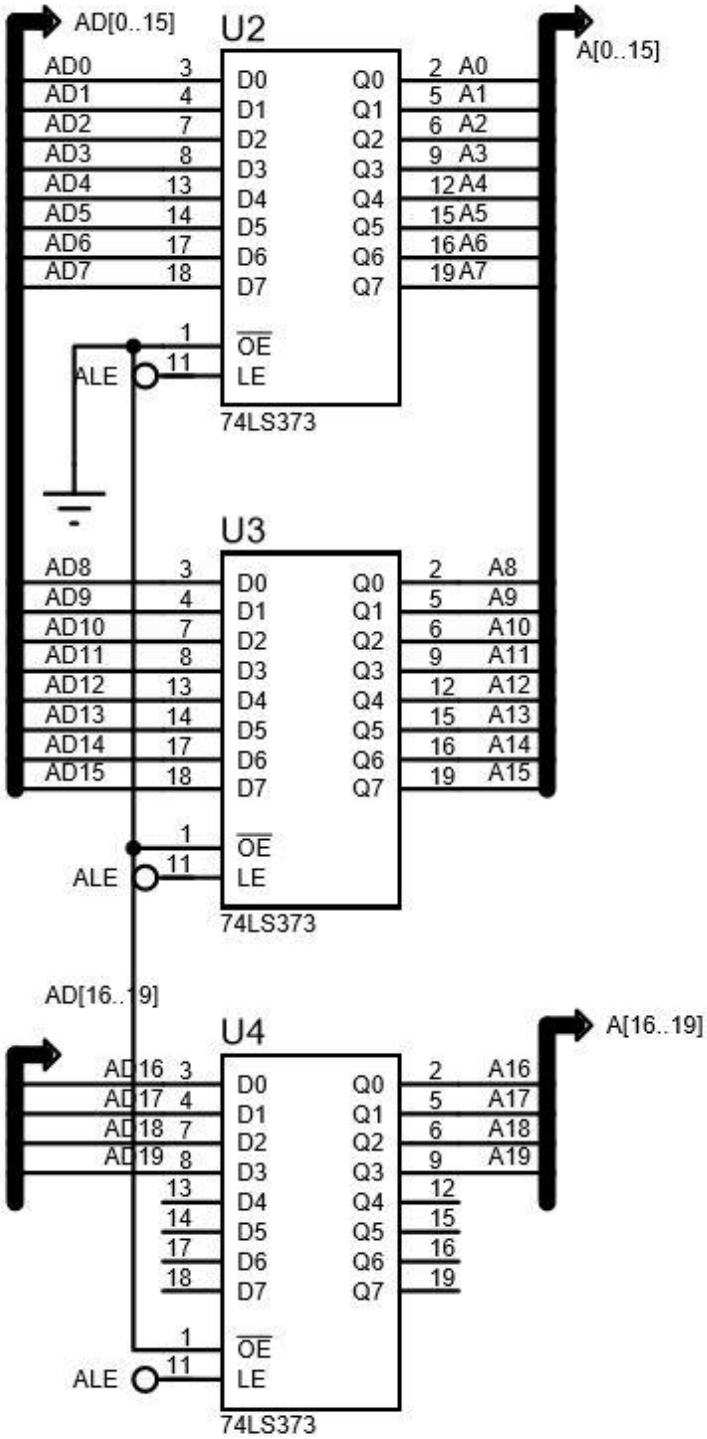
- EPROM (2732 x 2)
  4KB (Even Bank) + 4KB (Odd Bank) from
  EPROM1: 00000h – 01FFEh
  EPROM2: 00001h – 01FFFh
- SROM (6116 x 2)
  2KB (Even Bank) + 2KB (Odd Bank) from
  EPROM1: 02000h – 02FFEh
  EPROM2: 02001h – 02FFFh

HARDWARE CIRCUIT DIAGRAM

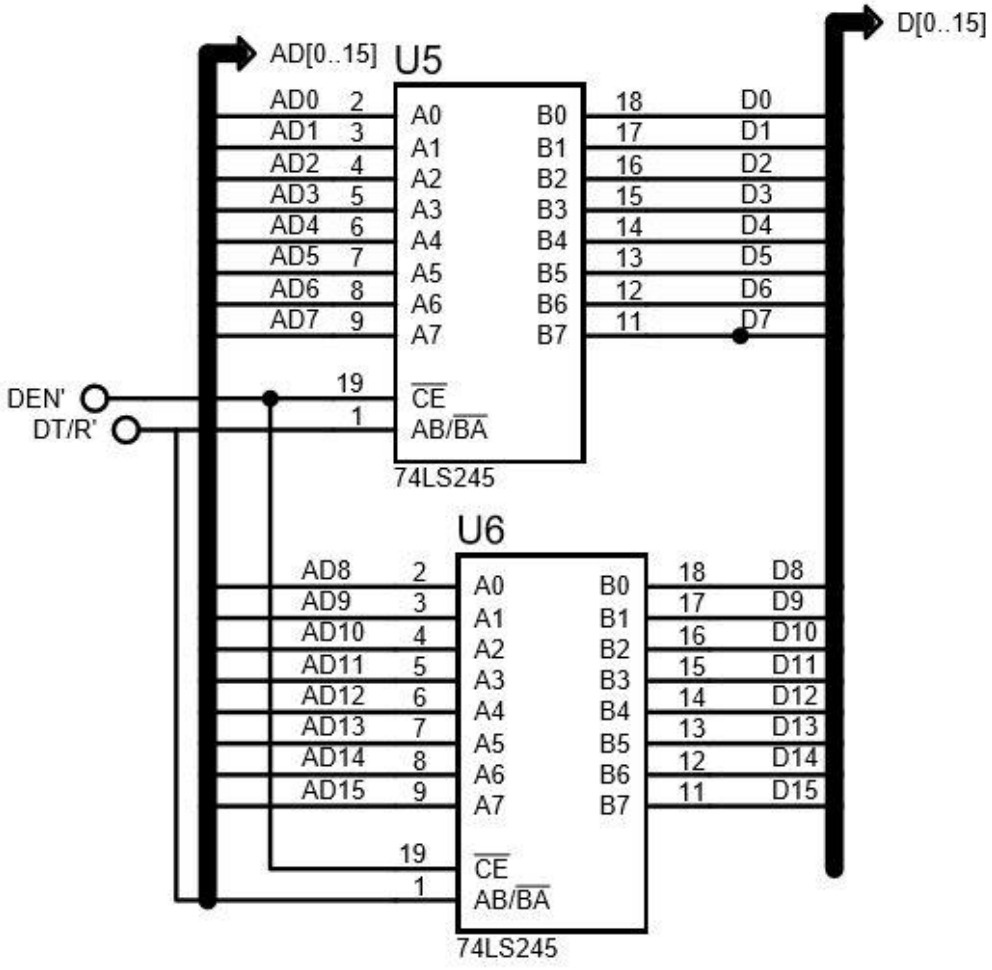
1. 8086



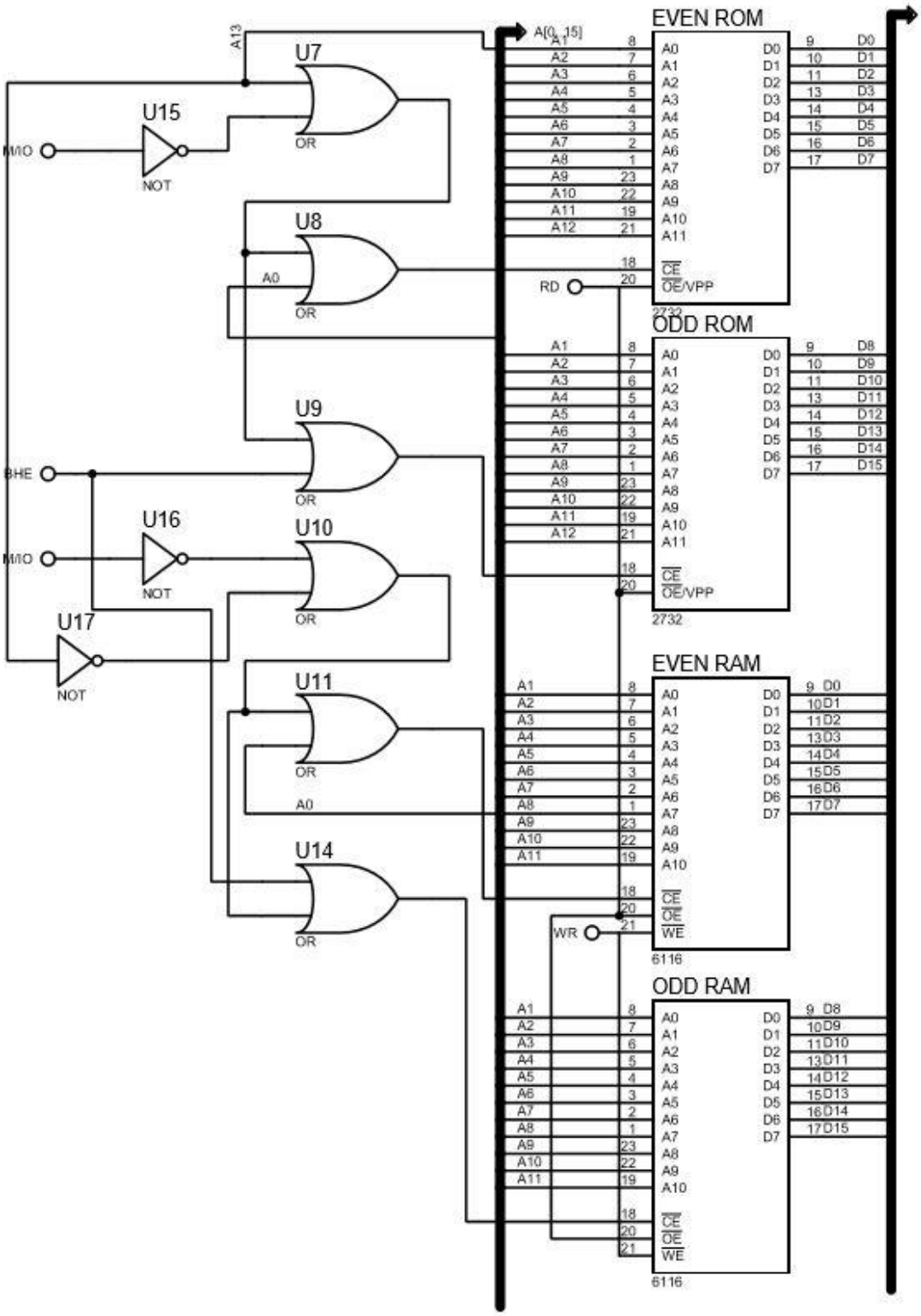
2. Address De-multiplexing.



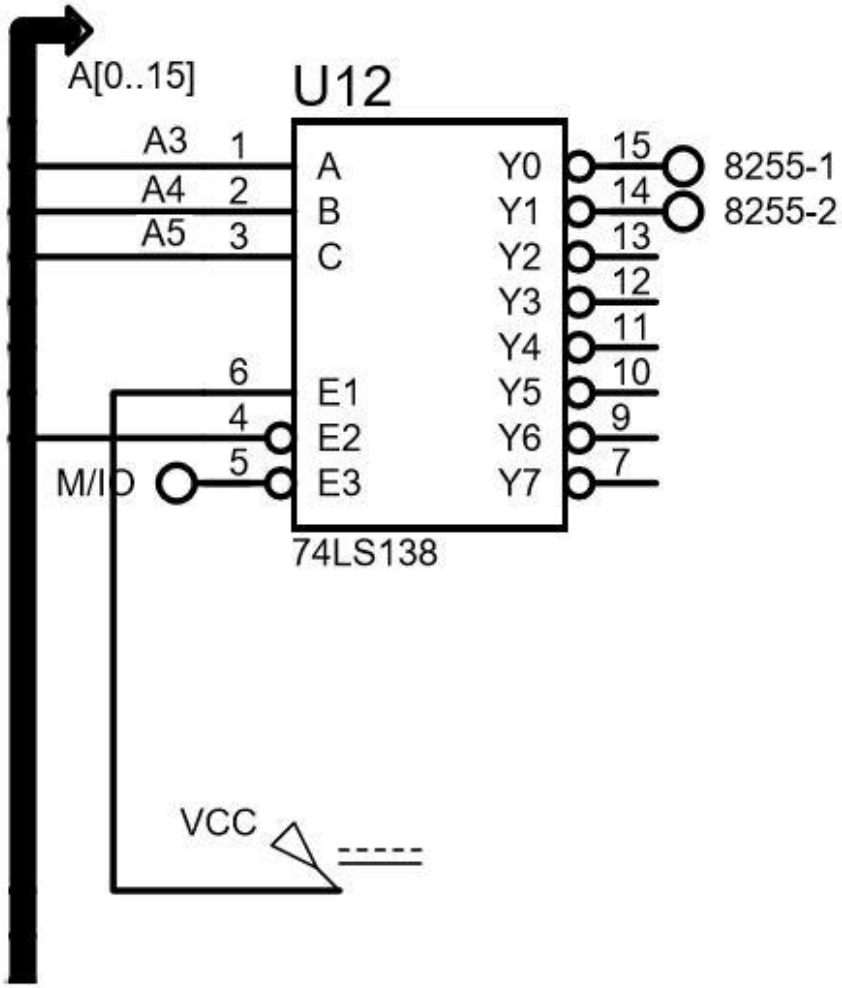
3. Data Buffer.



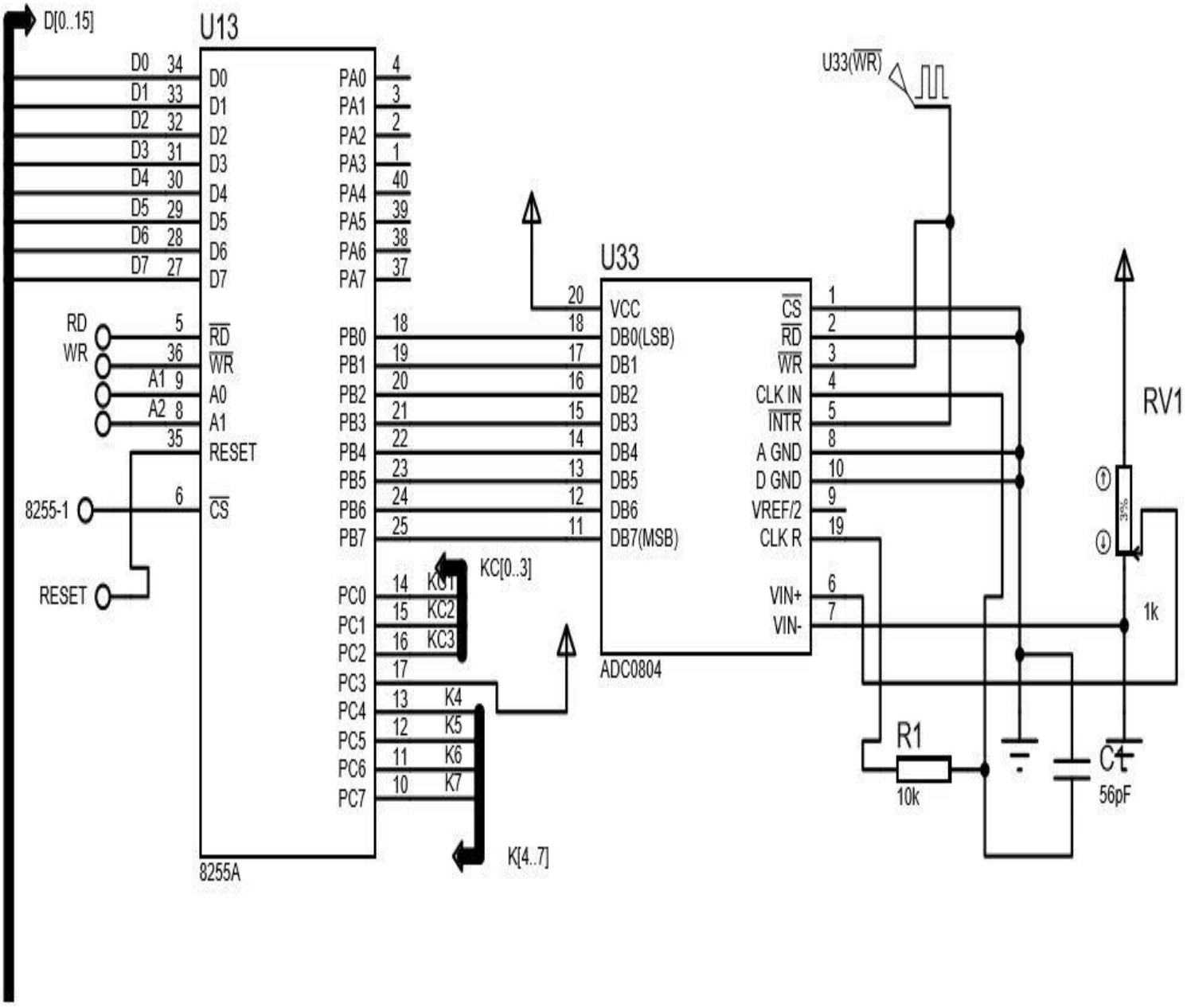
4. Memory Interface and Decoding Logic.



5. Decoder for selecting either one of PPI (8255).

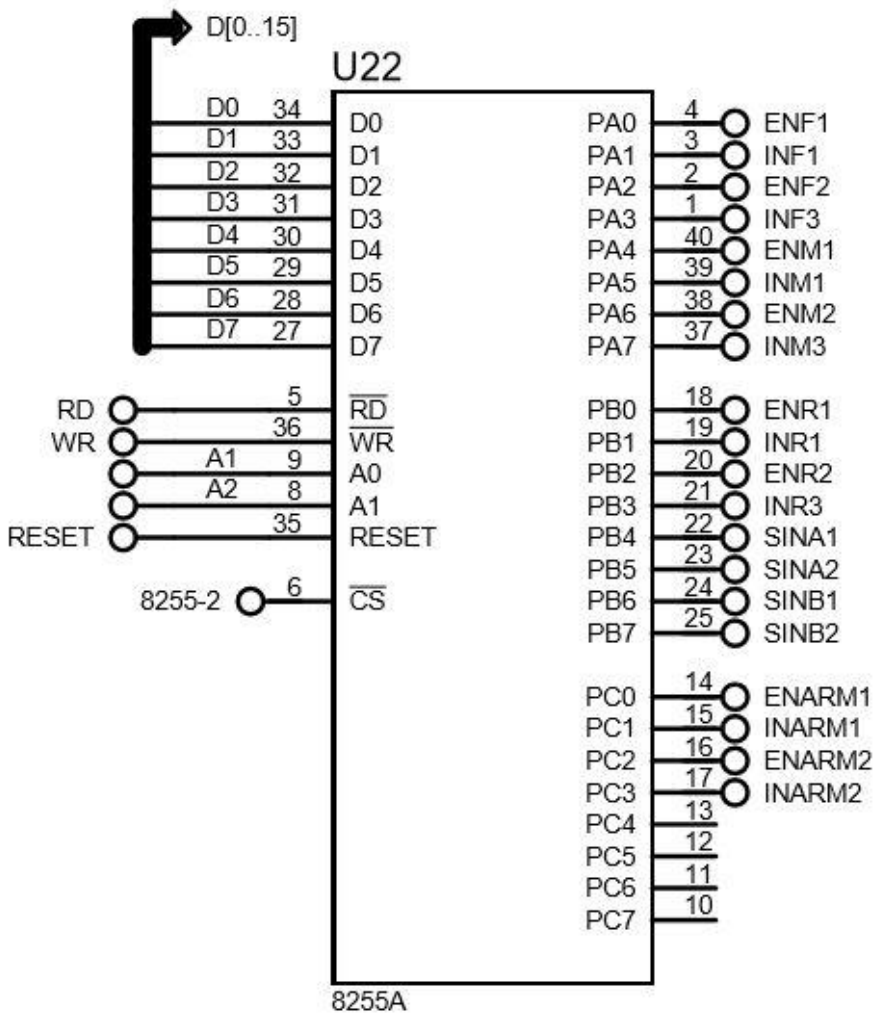


6. 8255-1 (Tilt-Detection and Keypad Input).
And ADC0804 (Gyroscope's simulation using potentiometer for angle detection). Angle Detection (PB0-PB7), Keypad Input (PC0-

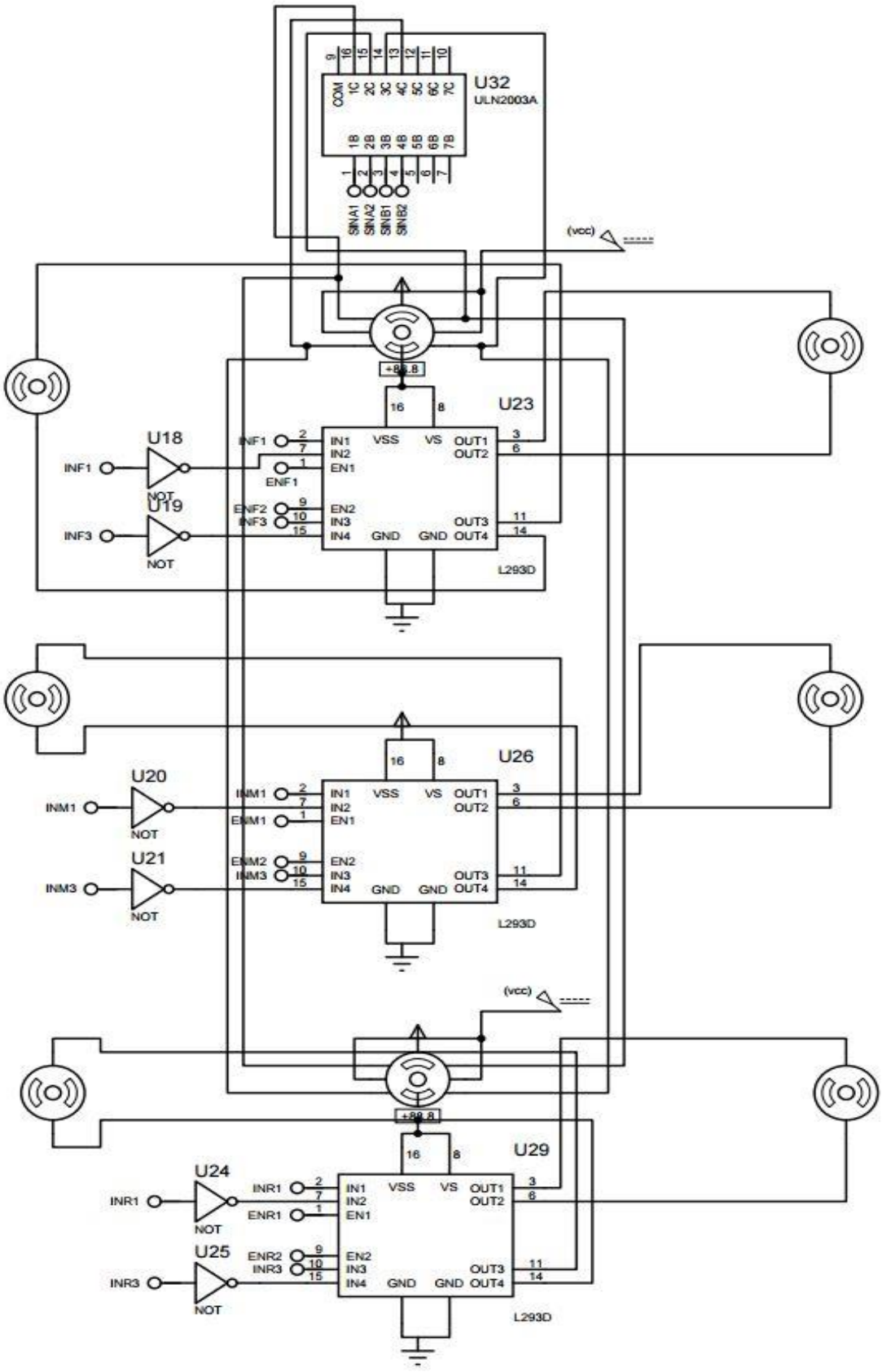


PC3), Keypad Output (PC4-PC7).

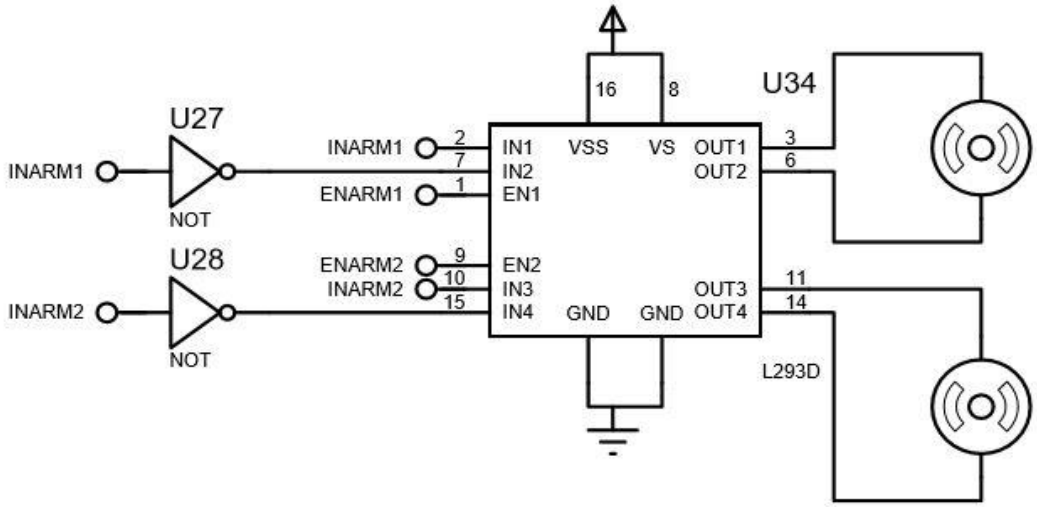
7. 8255-2. Front wheels (PA0-PA3), Mid-Wheels (PA4-PA7), Rear Wheels (PB0-PB3), Robotic Arm moment (PC0-PC3), Stepper motor control (PB4-PB7)

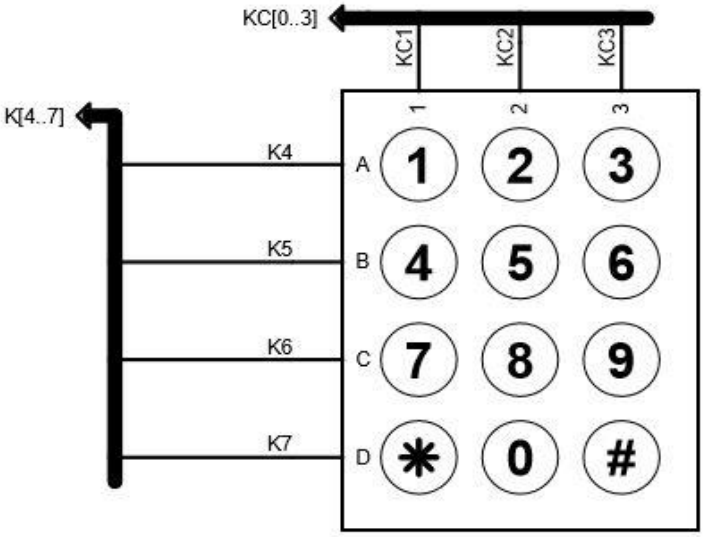


8. Stepper and DC-Motor Interfacing with 8255-2.

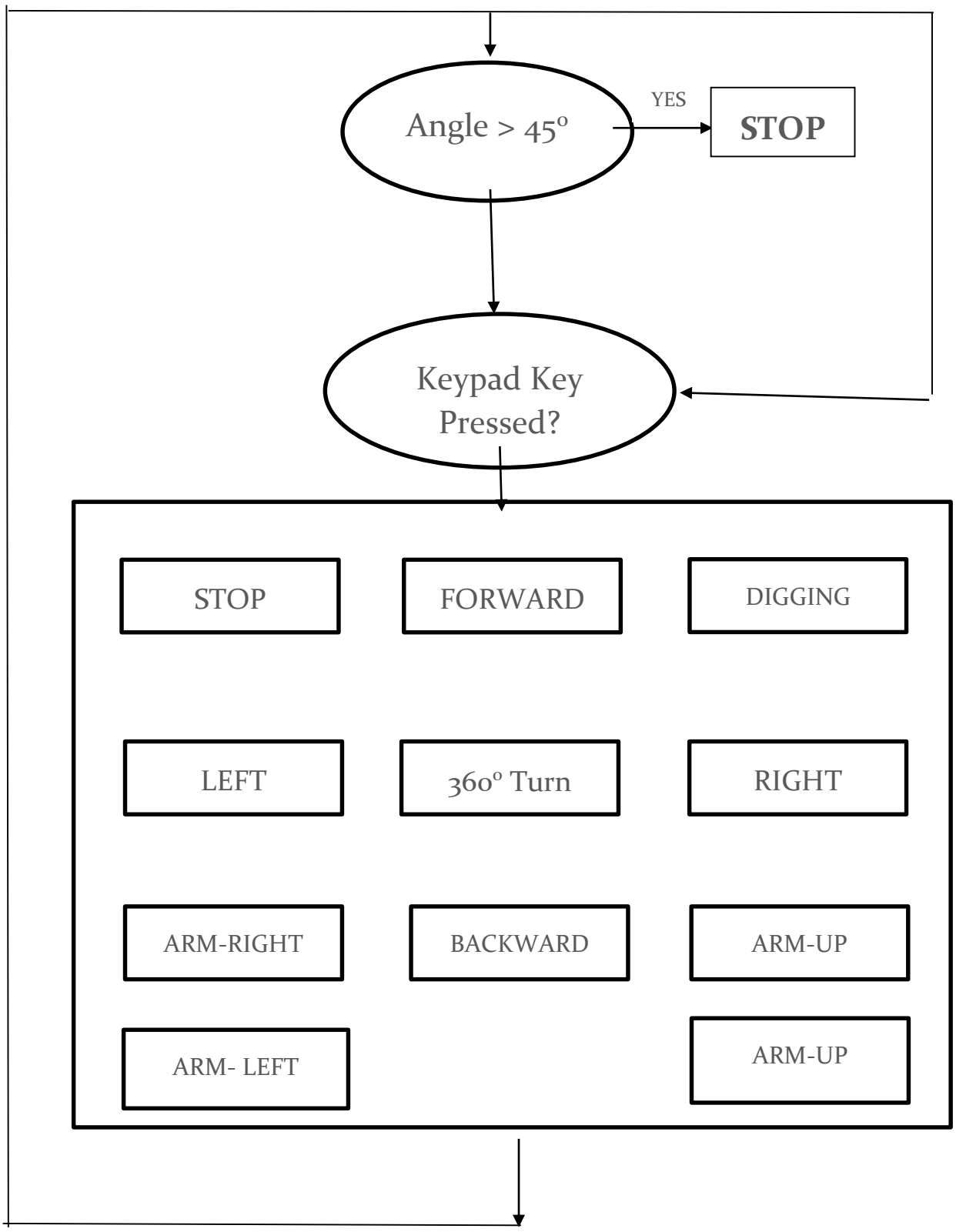


9. Robotic Arm interfacing with 8255-2 and Keypad.





FLOW CHART OF THE SOFTWARE



References:

- https://edge.edx.org/asset-v1:BITSX+F241+2015-16_Semester_II+type@asset+block/8255.pdf
- https://edge.edx.org/asset-v1:BITSX+F241+2015-16_Semester_II+type@asset+block/adc0804-n.pdf
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