Design Project
RPN Calculator

- Yuvraj Patel
- Brandan Balasingham
- Jonathan Poli

Objective

- Create a 4-bit RPN calculator .

What is RPN Calculator?

- Mathematical notation in which operators follow their operands
- Reverse Polish Notation (RPN) provides us the quickest way to enter data into the calculator.
- Example:

If we need to add 5 and 7, we would write 5 7 + instead of 5+7

Goals

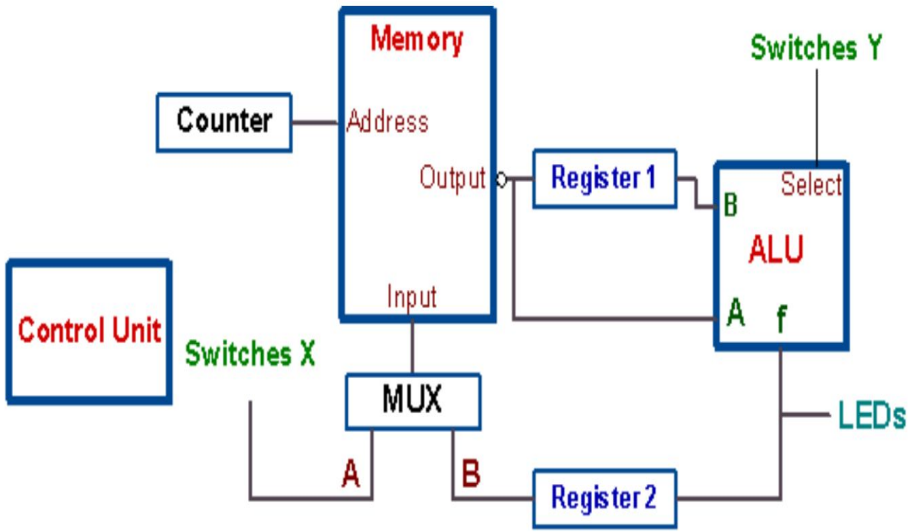


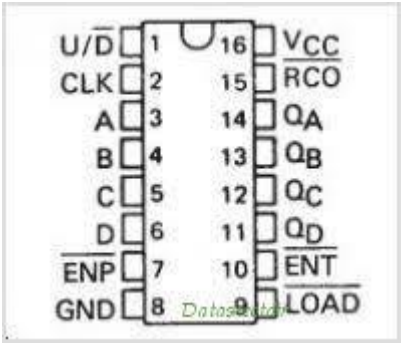
Fig. 1. Block diagram design of a 4-bit RPN calculator

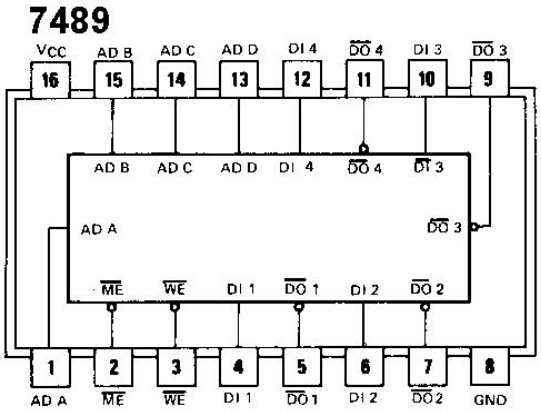
- Push operands on stack
  - Increment the Counter
  - Write the data into memory
- Functions
  - Output data from RAM to Register1
  - Decrement the counter
  - Latch the result into register 2
  - Write data into the memory.

Components Used

- 74LS138N (Decoder for the Control Unit)
- 74LS169N (Counter for the Control Unit)
- 74LS192N (Counter for the RAM)
- 74LS157N (Mux)
- 74LS181N (ALU)
- Two 7404 (Inverters)
- 7489 (16x4) RAM
- Two 7495 4-bit Shift Registers

Memory

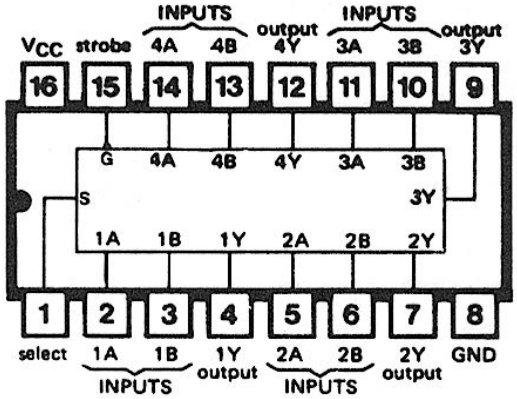




Functionality

- The counter determines the memory
- We used addresses 0 and 1 for our calculator
- U/D Bar High -> Count Up
- U/D Bar Low -> Count Down
- ENP(bar) and ENT(bar) High -> When we need to hold the counter

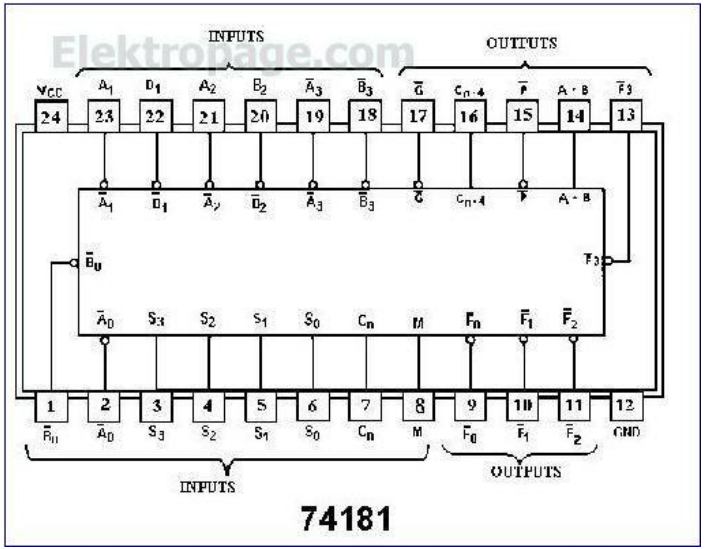
Multiplexer - 74LS157



Functionality

- Contains inverters and drivers to supply full-on chip data selection to 4 output gates.

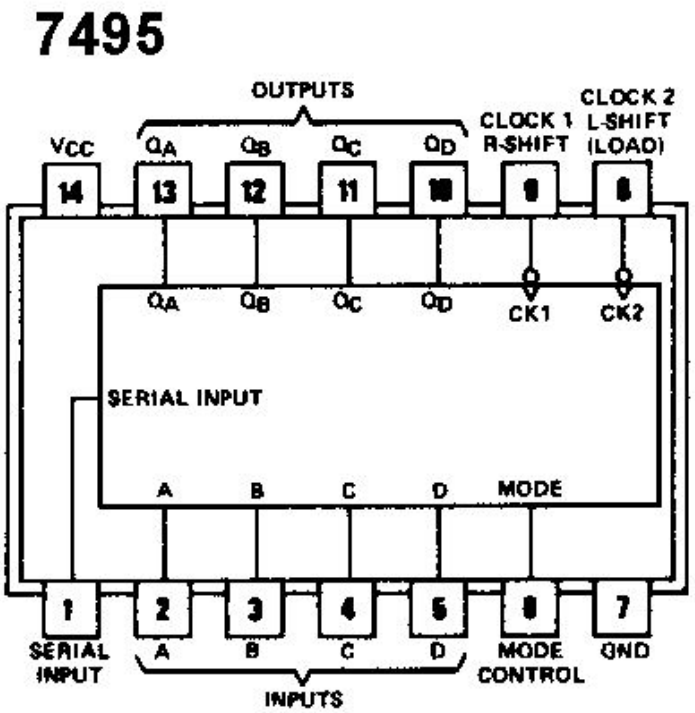
ALU



Functionality

- It is combinational digital electronic circuit that performs arithmetic and bitwise operations
- You choose different combinations of switches for different types of function.
- For example, F= A plus B, the combination will be S3-HIGH, S2-LOW, S1- LOW and S0-HIGH

Registers



Functionality

- The mode control changes from low to high to enable the register.
- In this lab, register 1 is controlled by Y4 of the decoder (74138) and register 2 is controlled by Y5.

RTL Code

FETCH: IR ← [1..0]

PUSH1: WE← 0, Select1 ← 0

PUSH 2: UP ← 1,

FUNC1: Enable3 ← 1

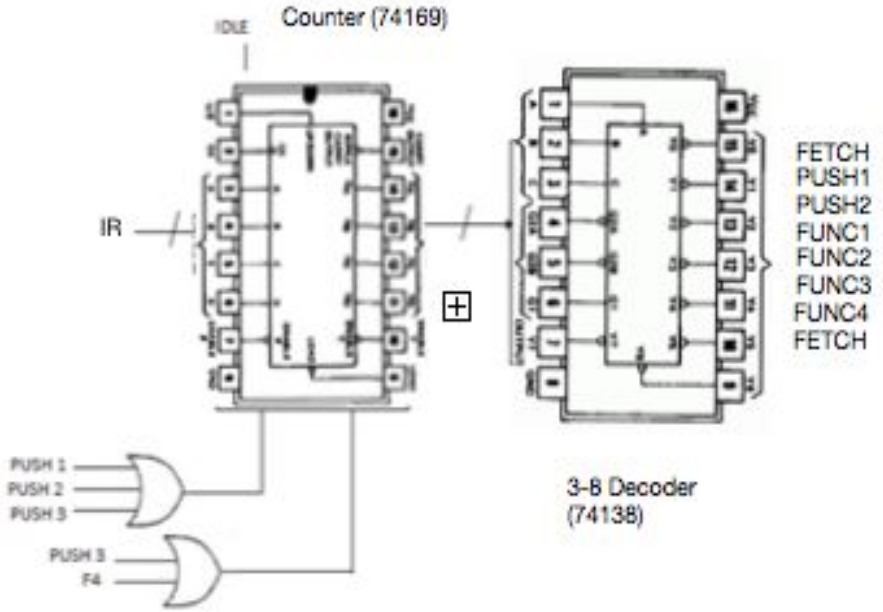
FUNC2: DOWN ← 1

FUNC3: Enable2 ← 1

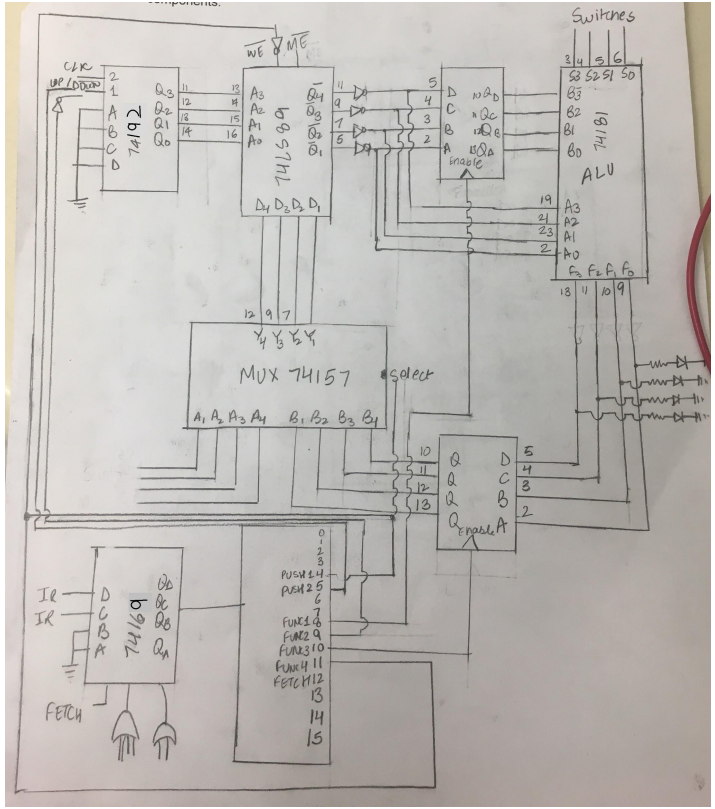
FUNC4: WE← 0, Select1 = 1

Control Unit Design

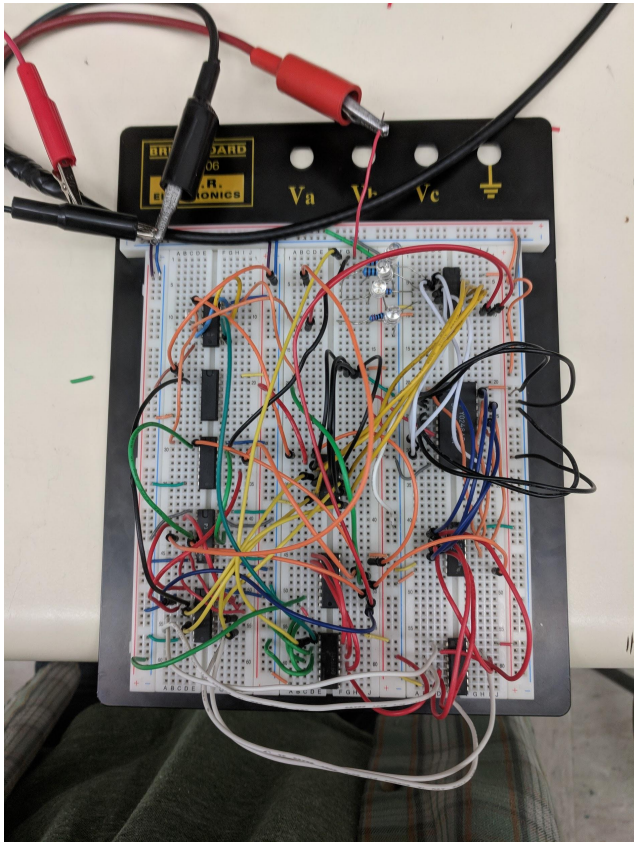
- The control unit is a combinational circuit that generates control signals (2-bit stack mode-select, and 4-bit ALU operation-select) based on which one of the buttons has been pushed.
- We can assume that only one of the 3 buttons could be pushed at a time.



Implementation



Circuit



Issues

- Burning out of LEDs and Chips
- Random voltage spikes when working with our calculator
- Potential shorts in our circuit