

Digital Scope

8-1-87

7:05 pm

This project is a stand alone, microprocessor controlled, digital measuring device. Its design is based entirely on my own ideas and will be built from scratch.

It should have the ability to give its user a rough estimate of a signal's waveform, relative amplitudes, and frequency.

General specifications are as follows:

- ① Totally self contained with the exception of power source.
- ② The ability to sample an analog signal and display a facsimile.
- ③ A display consisting of a matrix of light emitting diodes
- ④ At least one external analog probe

Alan Lilly

Technical Discussion

8-3-87

10:32 pm

The physical appearance of the digital scope device will consist of one main board with all circuit components mounted. Adequate space will be left for future expansion and adaptations. The heart of the system is the 8088 microprocessor. It will execute the permanent on-board software. The software will be stored in a 2716 EPROM that has been decoded and wired for the zero-page of memory. Approximately 4K bytes of RAM will be located above the reserved operating system memory. An 8255 port chip will be used to interface the microprocessor with ~~be used to~~<sup>as 8-3-87</sup> an ADC 804 analog to digital converter, which shall be set in free-running mode.

Alan Lilly

Technical Discussion  
Continued

8-3-87

11:00 pm

The on-board software will read the digital samples from a port into random access memory as quickly as possible. When a sufficient number of samples have been stored, each sample will be decoded and its relative amplitude displayed.

The display will contain 512 light emitting diodes matrixed into a 32 column by 16 row grid. Each column and each row will have its own driver in order to supply the current necessary to light each LED. The driver circuitry will be connected to 74154's, 4 line to 16 line decoders. The 32 columns will require 2 decoders and the 16 rows shall only need 1 decoder.

Alan Lilly

Technical Discussion  
continued

8-3-87

11:15 pm

The decoders will be connected to the two remaining ports. Due to the nature of the decoders, only one LED will be lit at any one moment in time. Therefore, the LEDs will be rapidly scanned one column at a time to properly show a waveform. This proto-type device will have several limitations. There will be no conditioning circuitry. Therefore, the measured signals amplitude is restricted. The A/D converter used in the used in the device has a slow conversion time. Therefore, the maximum measurable frequency will be in the hundreds range. Finally, due to cost, detailed resolution will not be possible for this unit.

Alan Lilly

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# Materials and Parts List

8-4-87

9:00 pm

#	ITEM	EACH	COST
1	8088 microprocessor	7.00	7.00
1	proto board	6.95	6.95
1	2716 EPROM	1.00	1.00
1	8255 port chip	6.00	6.00
7	74373 latch	.75	5.25
1	74138 decoder	.75	.75
1	A/D converter ADC804	4.95	4.95
3	74154 decoder	1.20	3.60
1	2114 4k RAM	2.50	2.50
512	Light Emitting Diode	.07	35.84
1	8284 clock	5.00	5.00
4	24 pin socket	1.00	4.00
1	16 pin socket	.75	.75
2	40 pin socket	<del>2.00</del>	4.00
8	20 pin socket	1.00	8.00
1	18 pin socket	.75	.75

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C<sup>≡</sup>

TOTAL 95.59

Alan Zilly

# Time Schedule

8-6-87

8:30pm

TASK	WEEK OF TERM														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Choose Project	XX														
Write Proposal		XXX													
Design Hardware		XXXX													
Get Parts				XXXXX											
Breadboard Hardware				XXXX											
Write First PPR							XX								
Write Software							XXX								
Test Project									XX						
Re-design Project									X						
Write Second PPR									XX						
Re-test Project										XX					
Wirewrap Hardware										XXX					
Test Project										XXXX					
Write Final Report													XXX		

Alan Lilly 6

# Labor Estimate

8-6-87 9:00pm

TASK	HOURS
Choose Project	-
Write Proposal	-
Design Hardware	10
Get Parts	8
Breadboard Hardware	5
Write First PPR	-
Write Software	5
Test Project	1
Re-design Project	-
Write Second PPR	-
Re-test Project	-
Wirewrap Hardware	4
Test Project	1
Write Final Report	-
Total Hours	34

Alan Lilly

Test Plan

8-6-87

9:30 pm

## Test Equipment

Oscilloscope

Digital Multimeter

8088 Emulator

Logic Probe

## Test Procedure

The software and hardware must be double checked, and all of the individual sections of the project must be tested and operational. After each individual section of the project has been tested separately, then the entire project can be tested.

I will use several short test programs.

Alan Lilly

## Test Plan Continued

8-6-87

9:40 pm

Each little program will test the ports, decoders, LED's, Analog/Digital converter, and memory seperately. When all sections function properly, the main program will be put into place and a series of varying signals will be applied to test accuracy and range of the final product.

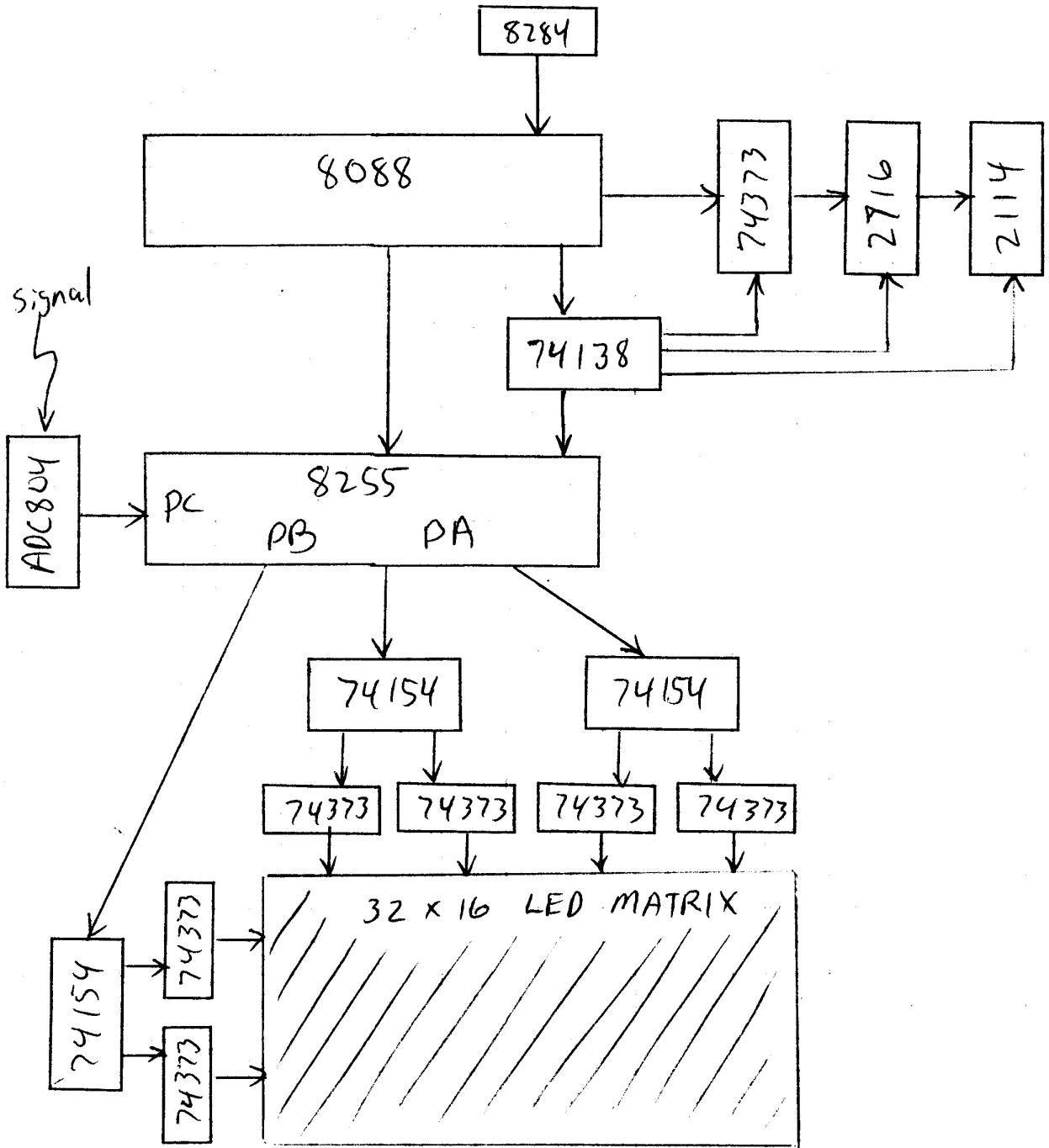
## References

Douglas V. Hall, Microprocessors and Interfaces, New York, NY:  
McGraw Hill Book Company, 1986,  
pp. 144-200

Alan Zilly

# System Block Diagram

8-6-87 10:00pm



## Design Improvements

8-20-87

A few alterations have been made since the previous circuit design. I have decided to use an 8155 port chip instead of an 8255. This will serve a dual purpose. It will take of the input/output operations and provide the necessary random access memory.

The 256-bytes in the 8155 is sufficient for operation.

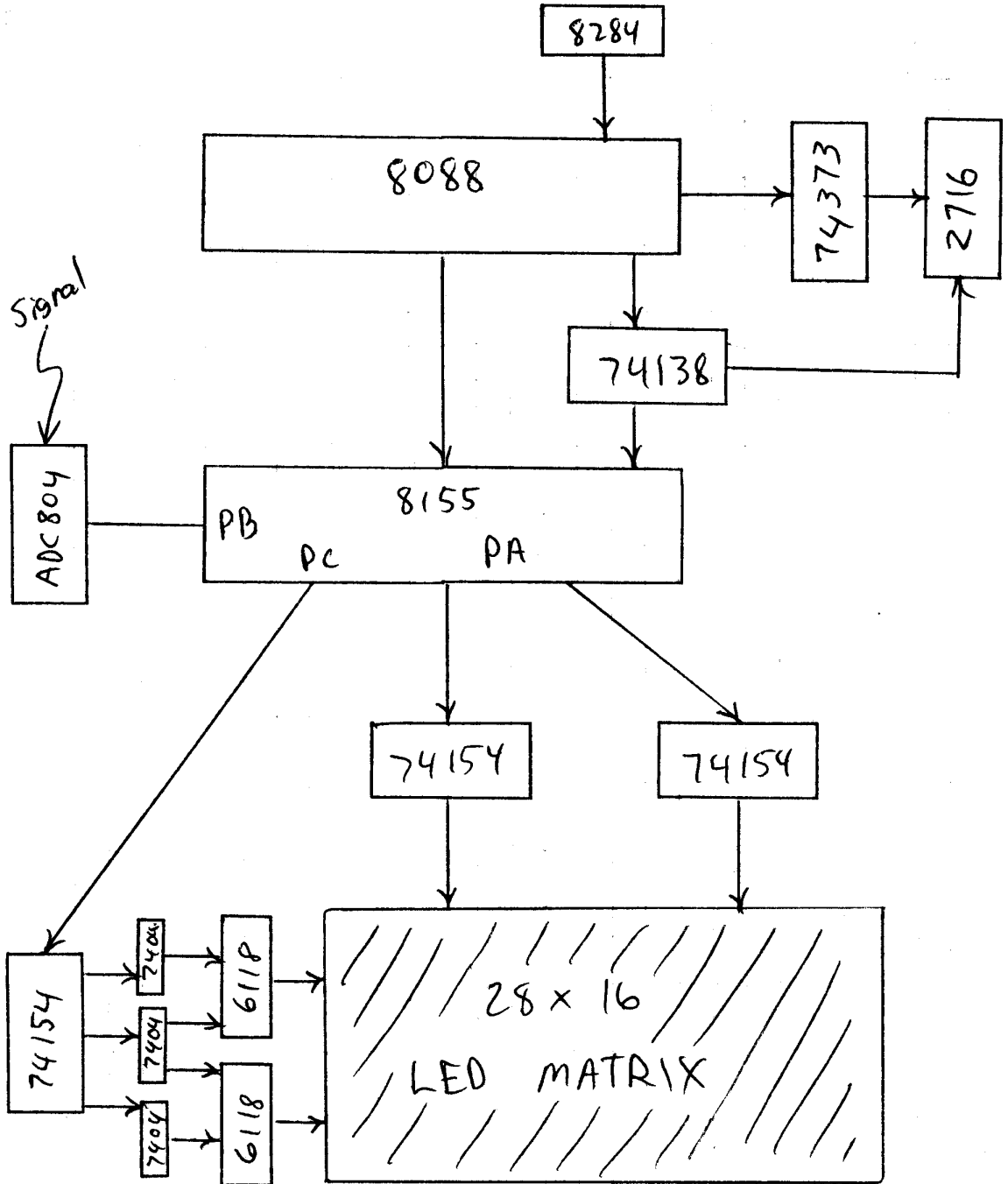
Therefore, the two external 2114 RAM chips have been eliminated.

The Light emitting diode matrix has been changed from  $32 \times 16$  to  $28 \times 16$  and the driver circuitry has been altered to increase the sink current.

Alan Jilly 11

# Updated Block Diagram

8-20-87



Alan Lilly

# LED Display Matrix

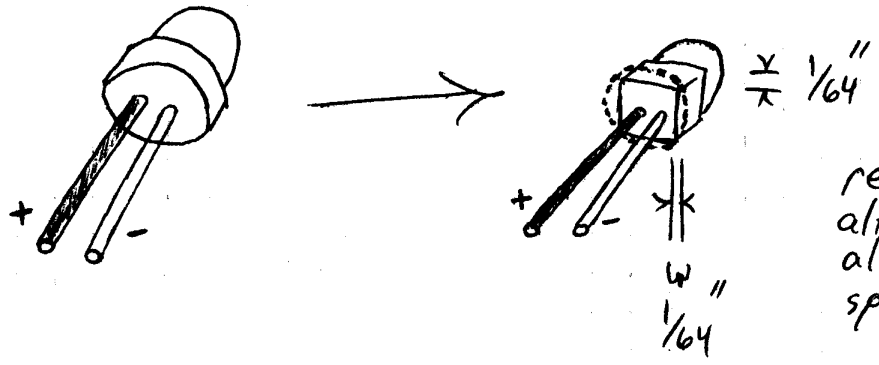
8-23-87

In order to maximize available space on the PC-board for the LED display matrix, all 448 LEDs had to be shortened in width by at least  $\frac{1}{32}$  of an inch. The PC-board has  $55 \times 40$  holes available. Therefore,  $28 \times 16$  LEDs can fit on the board as long as each LED is no greater than  $\frac{3}{16}$  of an inch in width. After all the LEDs had been inserted and secured, all positive leads were connected horizontally and all negative lead were connected vertically.

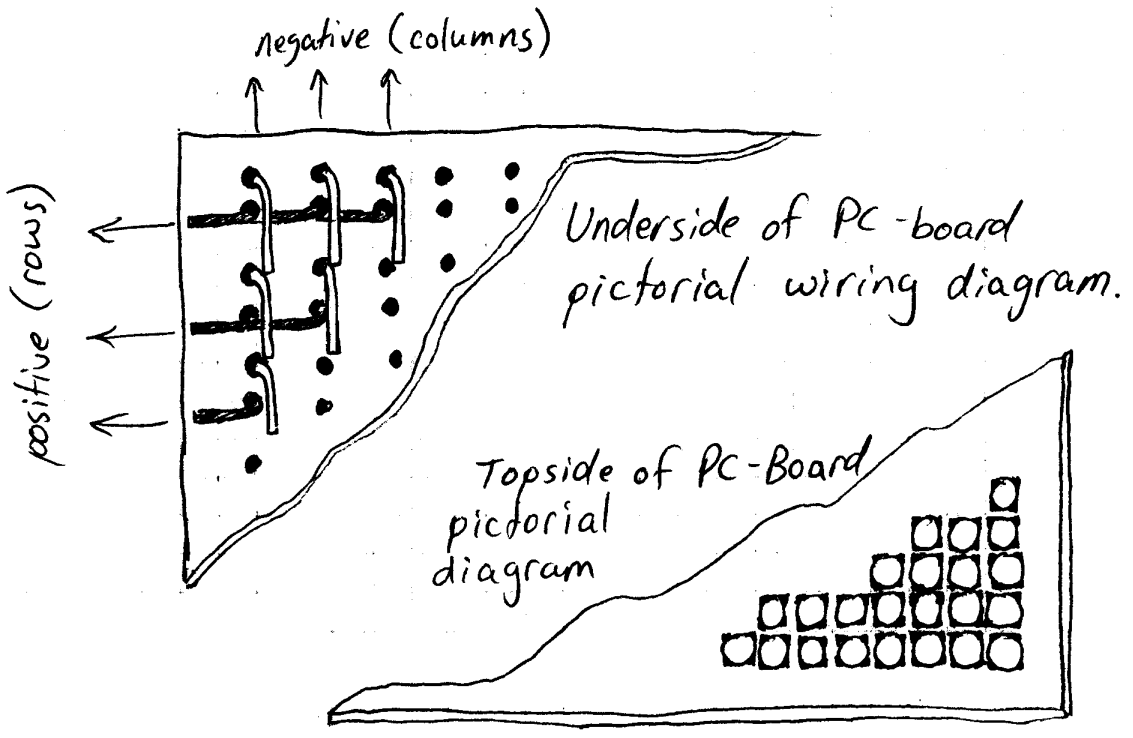
Alan Tully

# LED Display Matrix

8-23-87



required alteration to allow close spacing

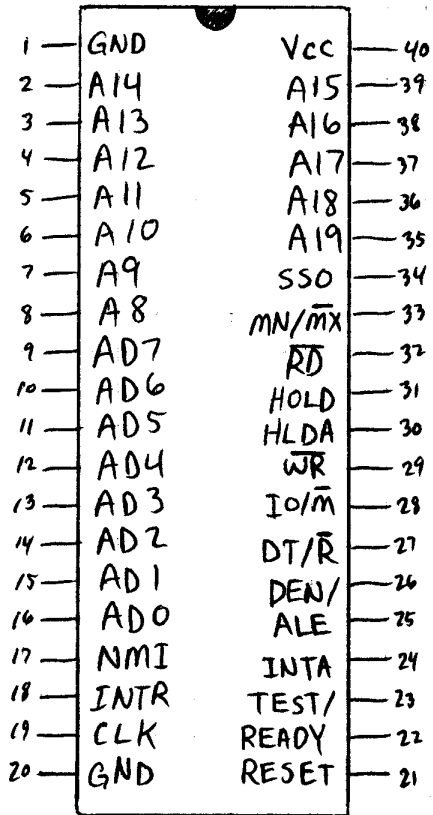


Alan Tilly

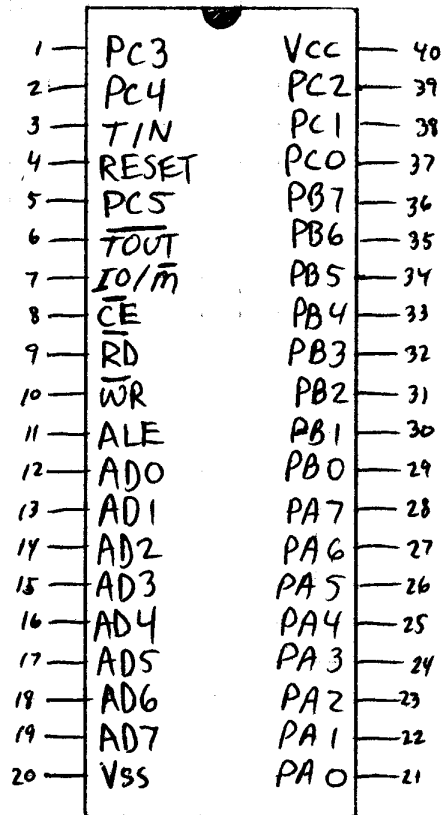
# Pin Configurations

8-25-87

## 8088



## 8155



Alan Lilly

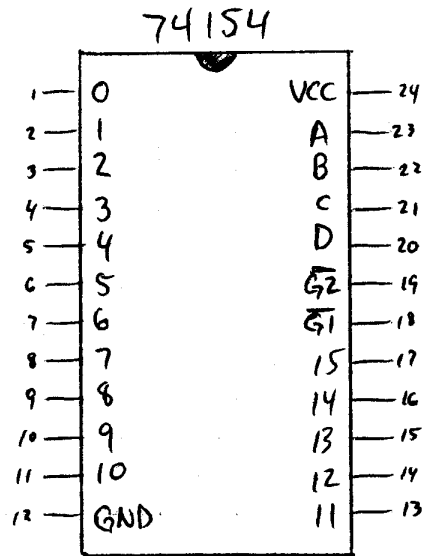
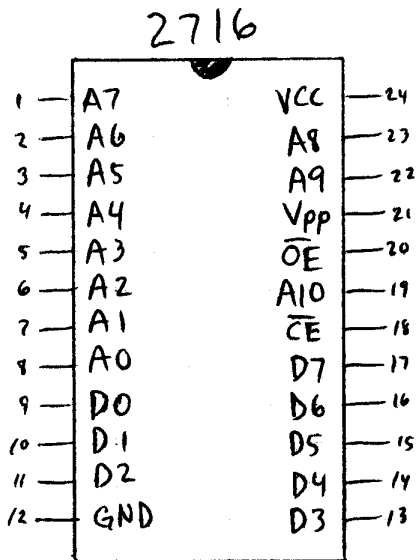
# Pin Configurations

8-27-87

Note: the output of the 74154  
4-16 line decoders is active low.

74154 - will be used as a row + column  
selectors for the LED display

2716 - will hold the main operating system program



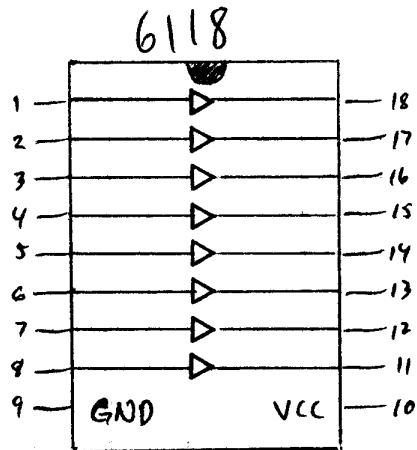
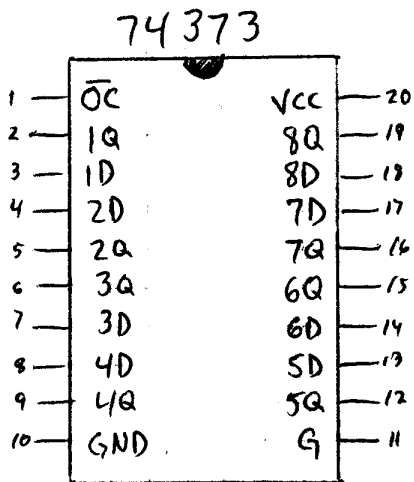
Outputs - active low

# Pin Configurations

8-27-87

74373 - will be used for address latching to the 2716 chip.

6118 - will be used to drive the display by providing the necessary sink current for the rows of LEDs.



8/27

B

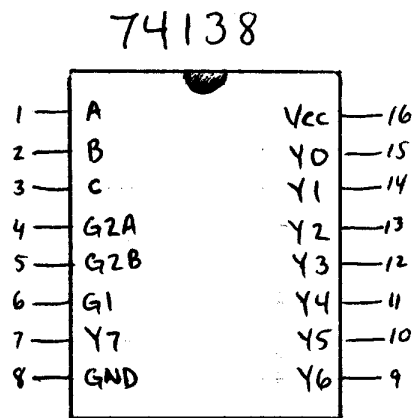
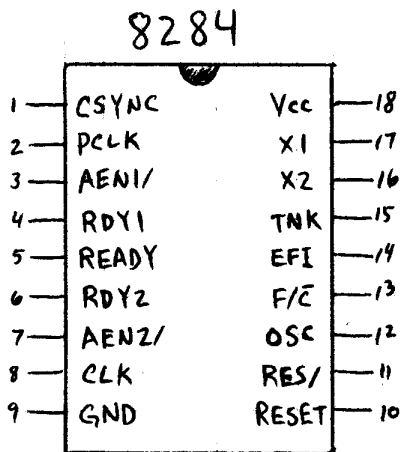
Alan J. J.

# Pin Configurations

9-9-87

8284 - will be used to generate the system clock and synchronize with system reset switch.

74138 - will be used for address decoding for the 8155 and 2716.



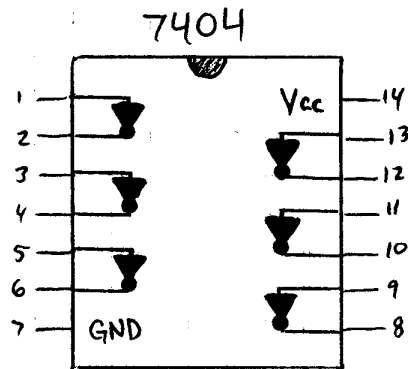
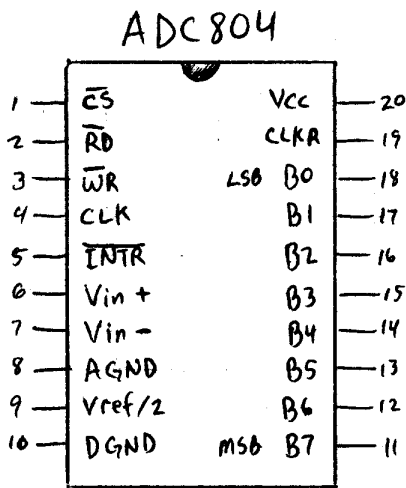
Alan Lilly

# Pin Configurations

9-9-87

ADC 804 - will be used to convert the external analog signals to digital format for the 8155

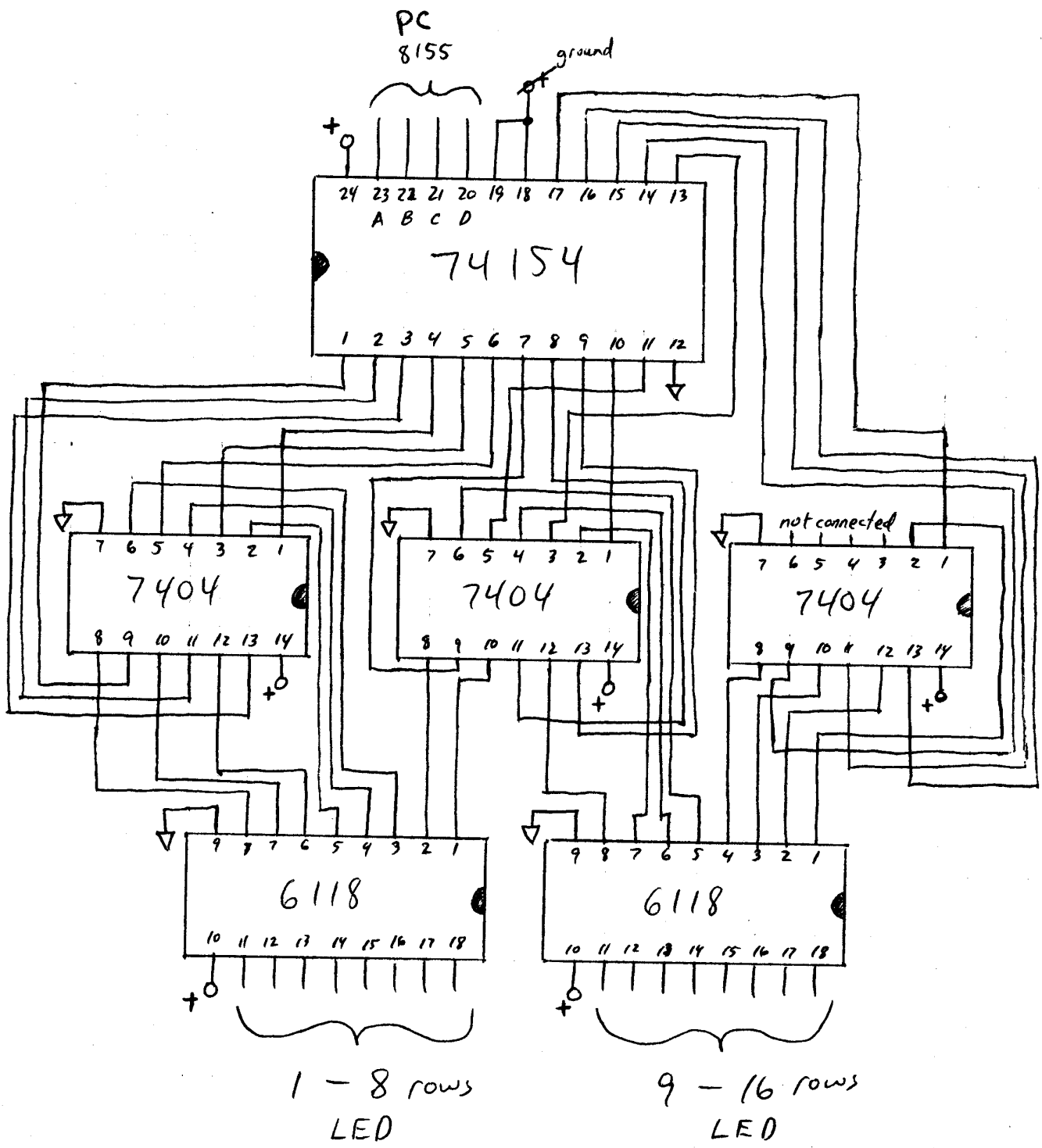
7404 - will be used to invert the row signals of the LED grid display.



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# Wiring Diagram (LED Rows)

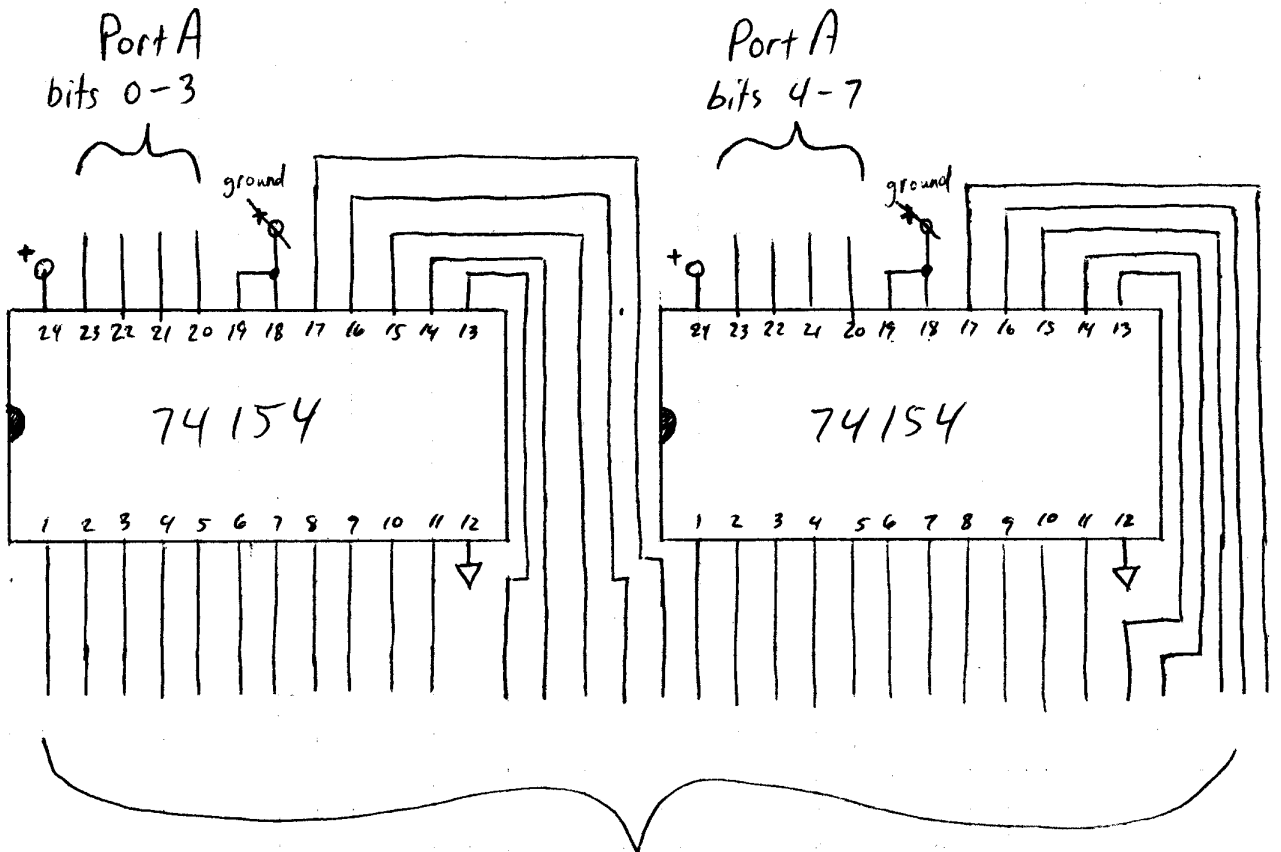
9-10-87



Alan Lilly 20

# Wiring Diagram (LED Columns)

9-13-87



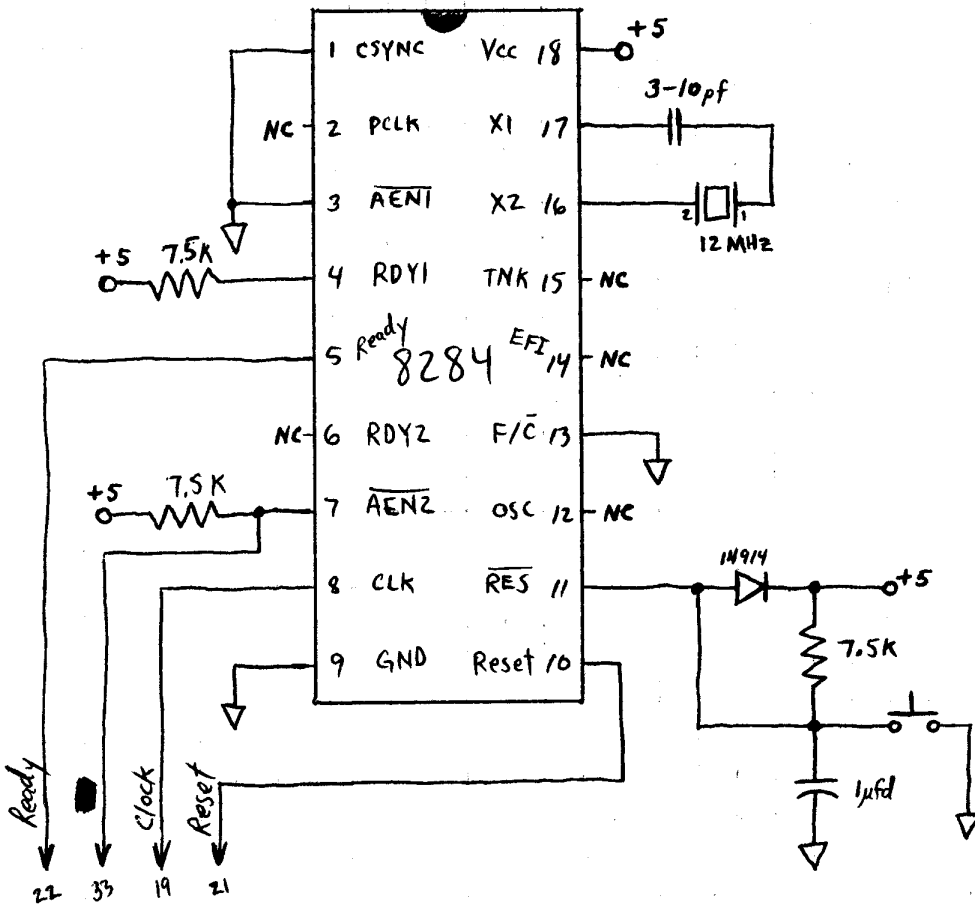
## LED COLUMNS 1-28

These 74154 (4 line to 16 line) decoders will provide sufficient sink current for the vertical columns.

Alan Lilly

# Wiring Diagram (Clock Chip) 9-14-87

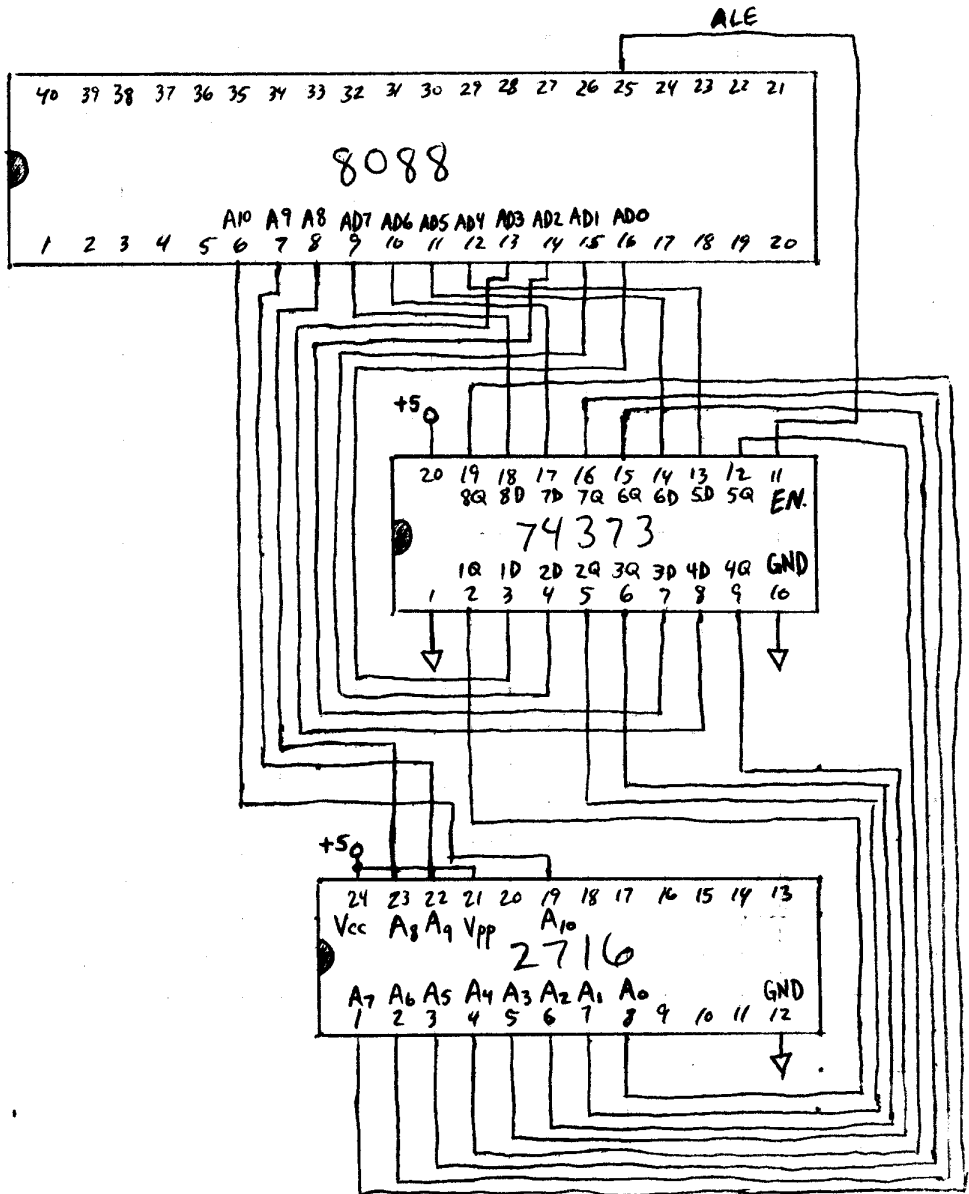
The 8284 provides the 4 MHz clock signal ( $12\text{ MHz} \div 3$ ) and has the reset switch circuitry for providing the system reset.



Alan Lilly

# Wiring Diagram (Memory) 9-14-87

## Address Latching



The system development software (to be "burnt") for the 2716 will be shown in later pages.

*Alan Lilly*

Construction

9-14-87

The wiring diagram on 20-21 has been constructed and is under test and evaluation for proper operation. I have also begun the wire wrapping of the diagrams shown on the preceding pages. The addressing of the 8155 port chip and the 2716 Eprom is still under consideration.

The system software will reside in the 2716 and shall be addressed for the starting location for the reset switch. (FFFF0)

9/17  
B

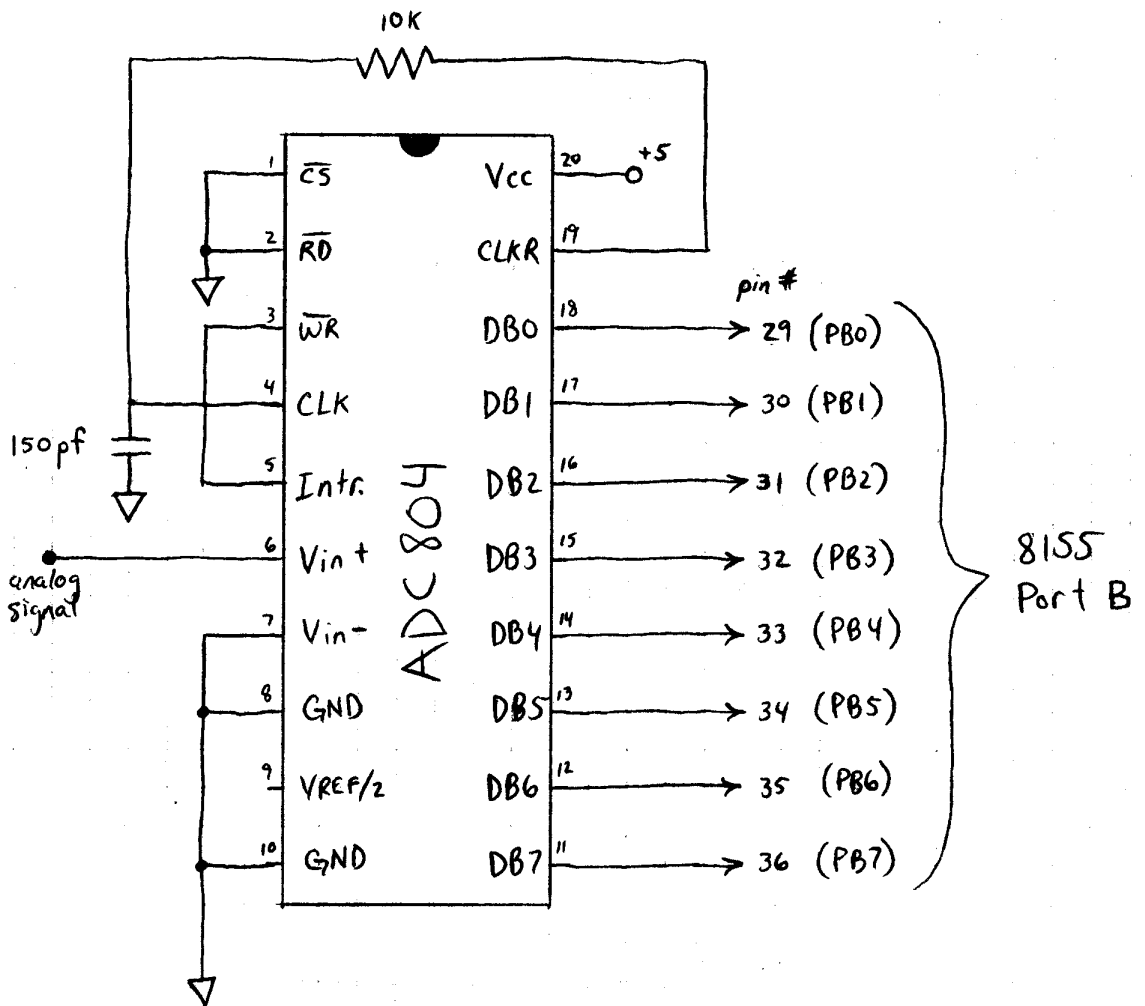
Alan Lilly

# Wiring Diagram

9-25-87

## Analog to Digital Converter

The device is in free running mode.

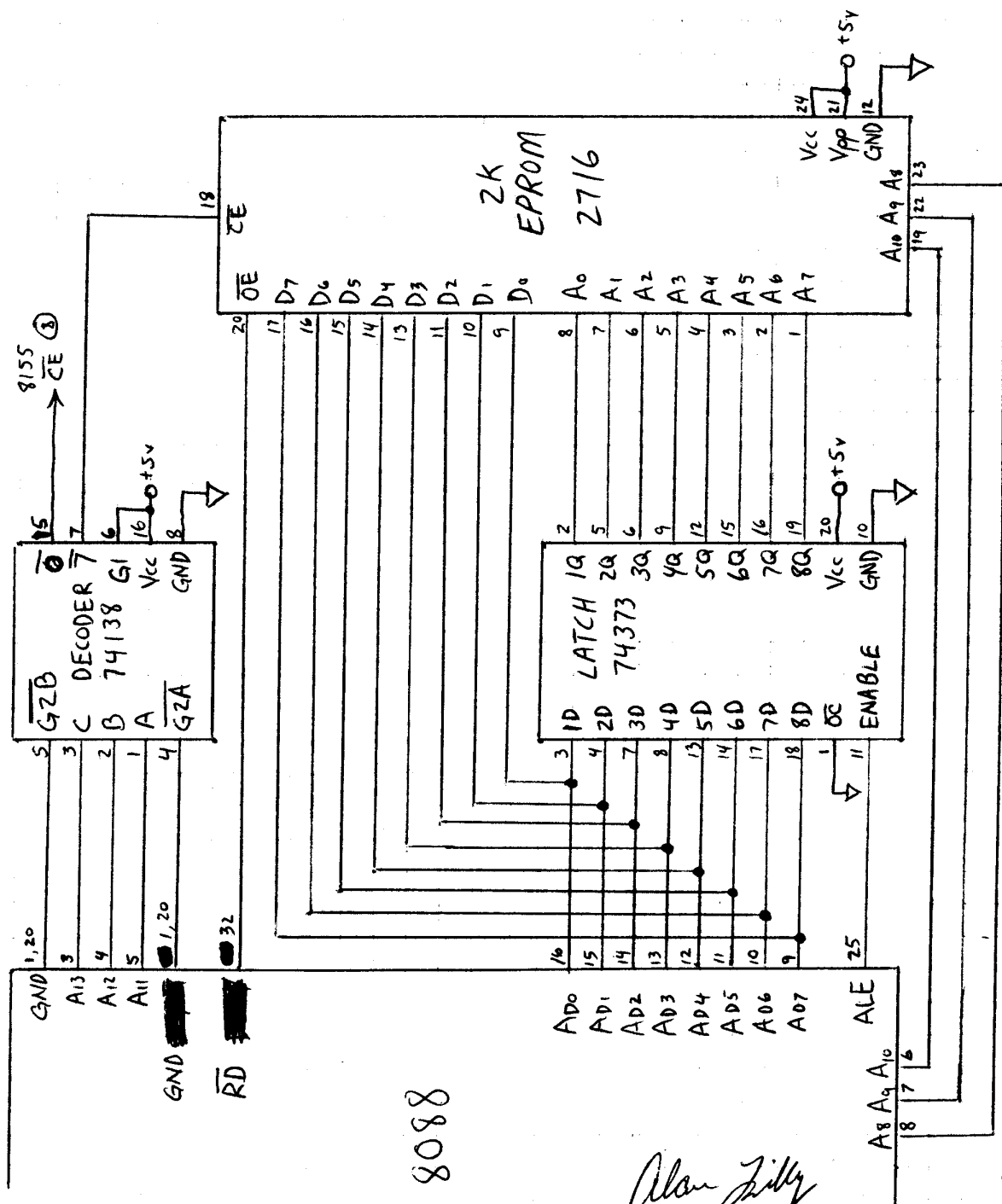


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# Wiring Diagram

9-27-87

Updated and simplified  
diagram of 2K Eprom

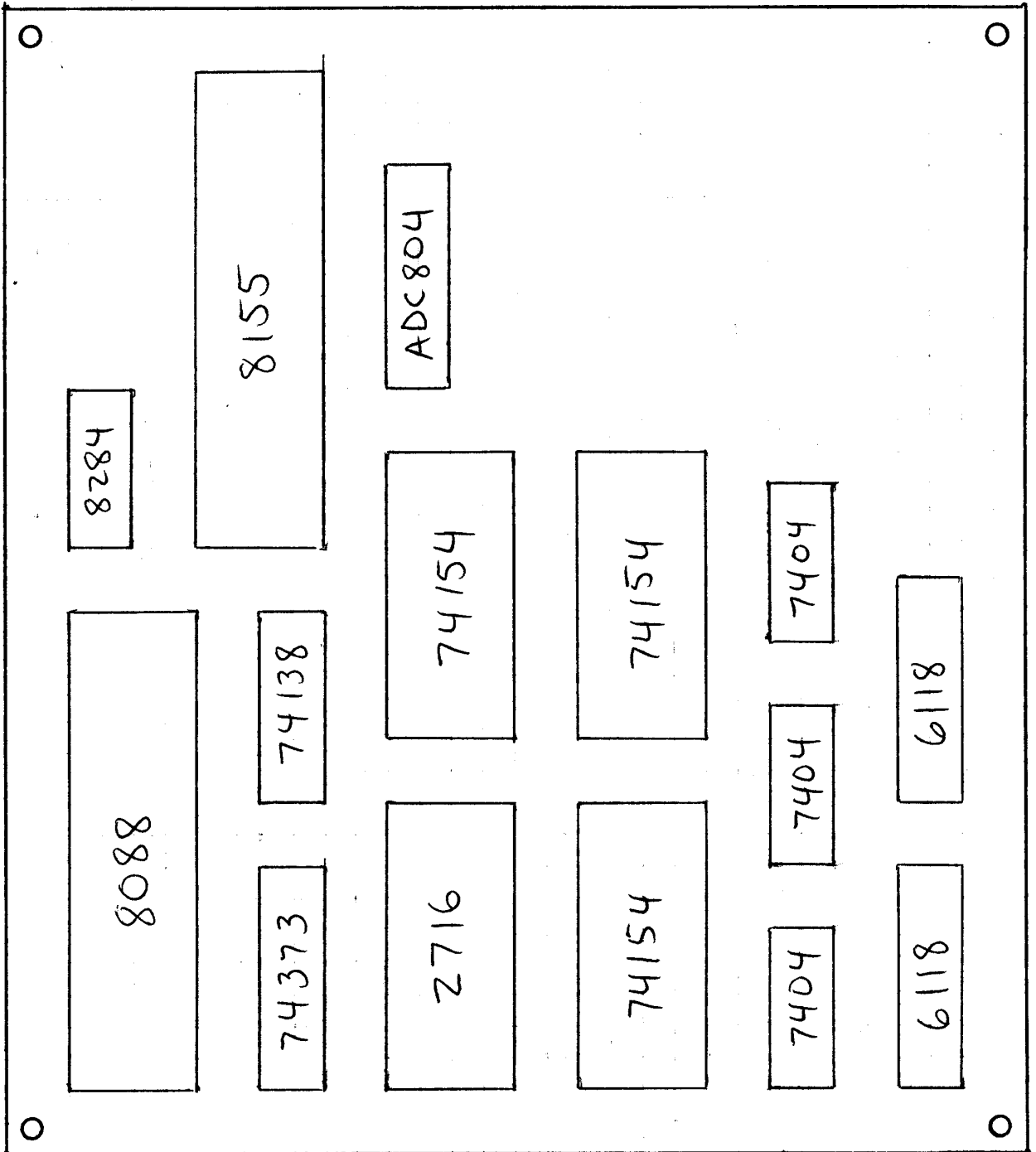


8088

Alan Zilly



# Parts Layout (Physical Diagram) 9-29-87

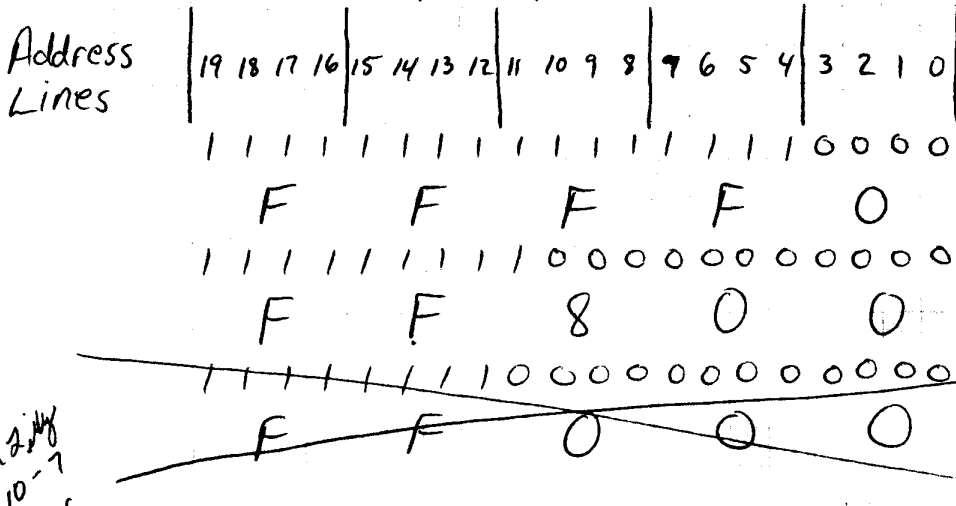


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# Addressing

9-30-87

8155, Eprom  
Address  
Decoder Lines



Reset Boot  
Location

Eprom Start  
Location

8155 Addressing  
Location

A Zilly  
10-7  
Error

Eprom burn locations

0 - 7FF

Eprom address locations

FF800 - FFFFF

8155 Control word

FF000

CW00001101

PA out  
PB in  
PC out

8155 Port A

FF001

COLUMNS

8155 Port B

FF002

A/D converter

8155 Port C

FF003

ROWS

8155 RAM

FF000 - FFOFF

A Zilly  
10-7  
Error Corrections  
on page 30

# Addressing

9-30-87

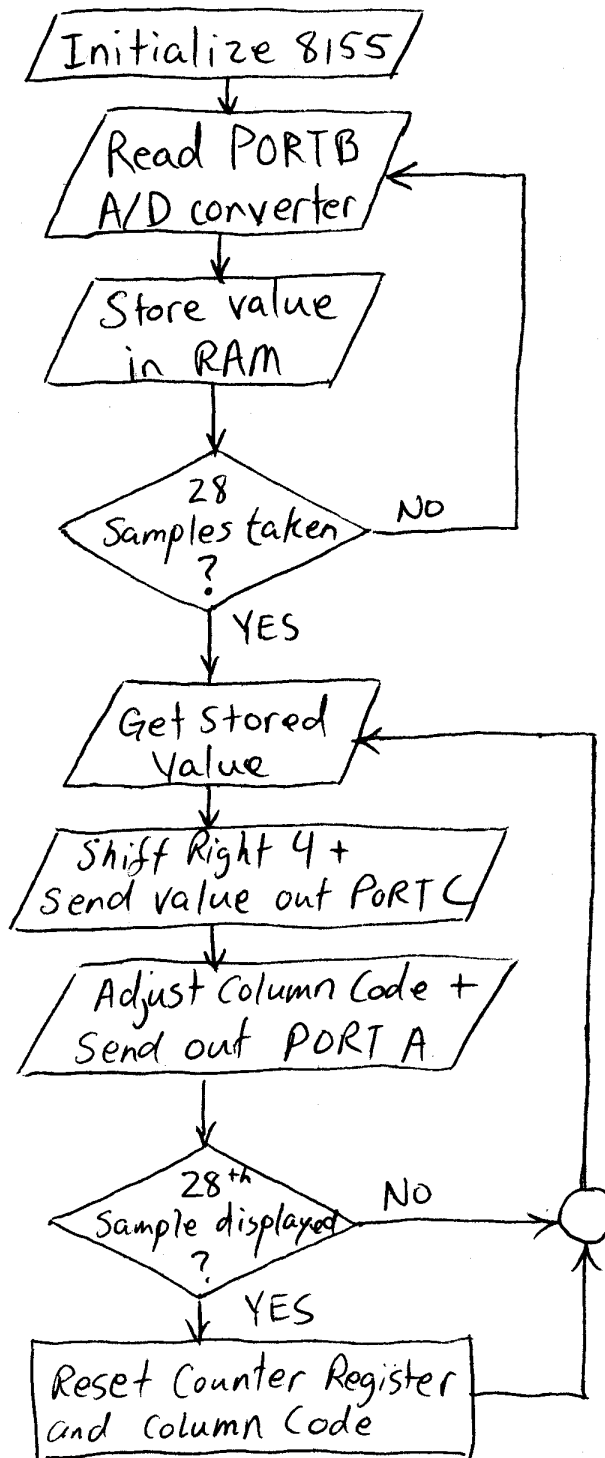
	<u>Address</u>	<u>Location</u>
8155 Control Word	00000	CW000001101
8155 Port A	00001	COLUMNS
8155 Port B	00002	A/D CONVERTER
8155 Port C	00003	ROWS
8155 RAM	00000	000FF

Eprom burn Locations 0 7FF

Eprom address Locations FF800 FFFF

# Main Program Flowchart

9-30-87



10/8  
B  
Overall  
(83) 31