

Magic-1 Homebrew CPU

Bill Buzbee, Half Moon Bay, CA

Magic-1 Homebrew CPU

CPU: Custom design

Construction:
Wire-wrapped TTL

Clock speed: 3 Mhz

Memory: 4 MB

Architecture:
modified 1 address

Address bus:
22 bits + I/O space

Addressing modes:

Reg-Reg
Base + offset

Push, Pop

Registers:

General: A, B
Bases: SP, DP
Control: MSW, PTB
Special: PC, C

Hardware page table

Data bus: 8 bits

ALU width: 16 bits

Modes: supervisor & user

External interrupt lines: 6

IDE hard drive interface

Serial ports: 2

Real time clock

Full front panel

<http://www.homebrewcpu.org>

Magic-1 design & construction: Bill Buzbee

Enclosure and front panel: Alistair Roe

Design & debugging help, inspiration and encouragement:

Ken Sumrall
Dave Conroy
Andrew Holme
Ben Franchuk
Gil Smith
Mark Atherton
Ron Watkins

TTL Mark
Al Kossow
Simir Ribic
TriPheonix
Dave Brooks
Barry Cross
Ian White

Attila Szabó
John Doran
Hans Summers
Dennis Kuschel
Merlin Skinner
...and many others

Thanks!

Serial 0

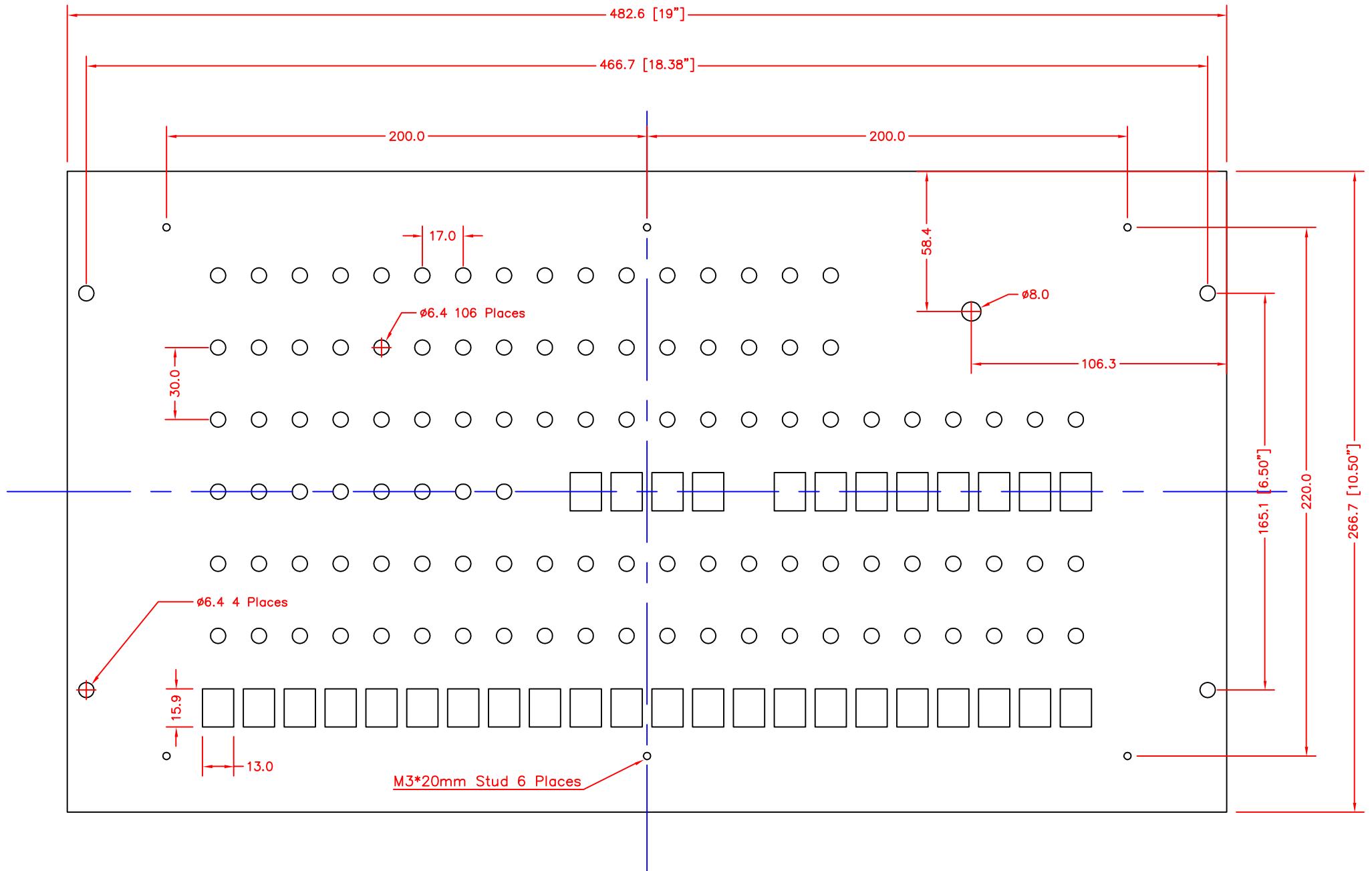
Compact Flash

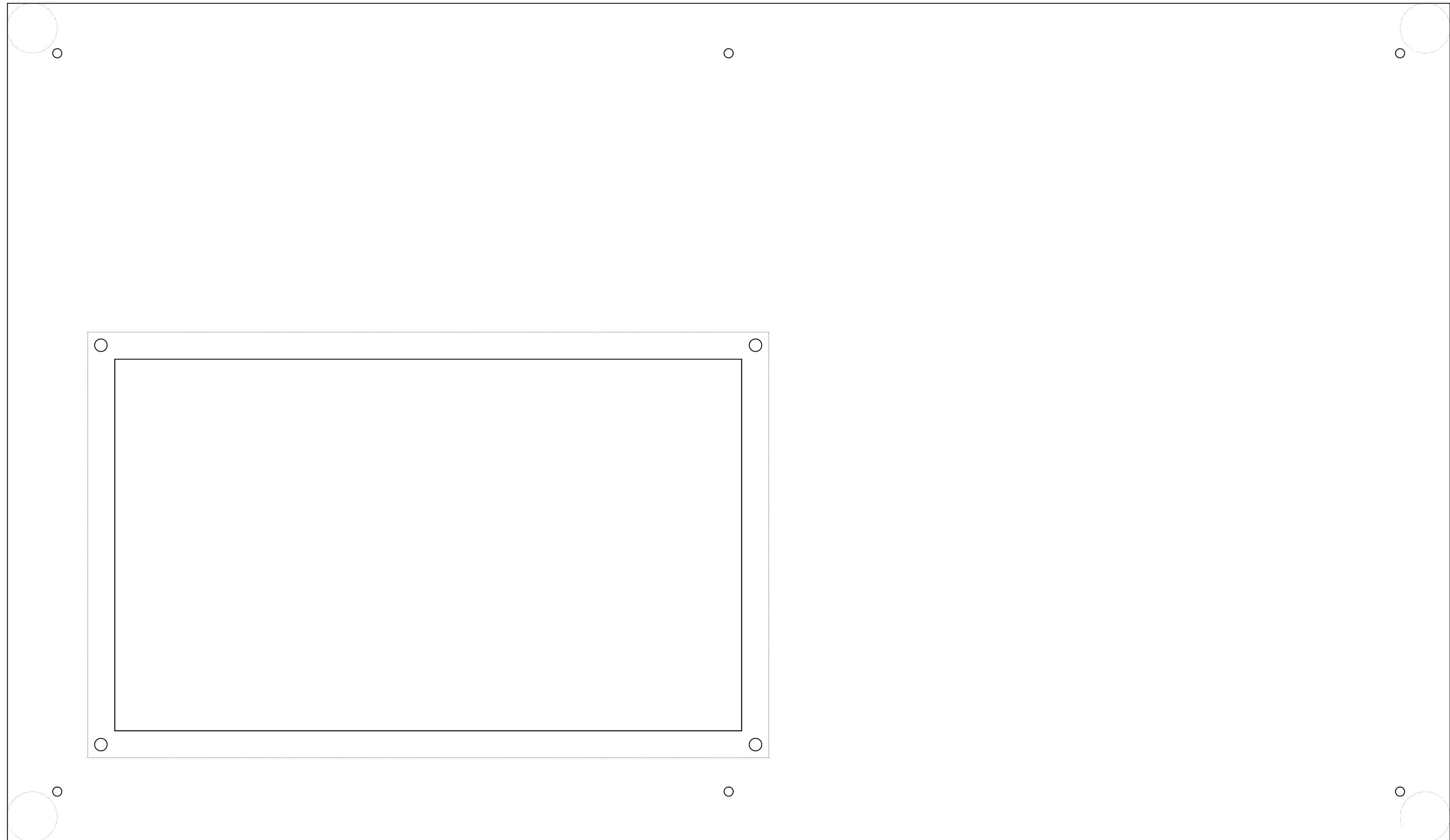
Serial 1

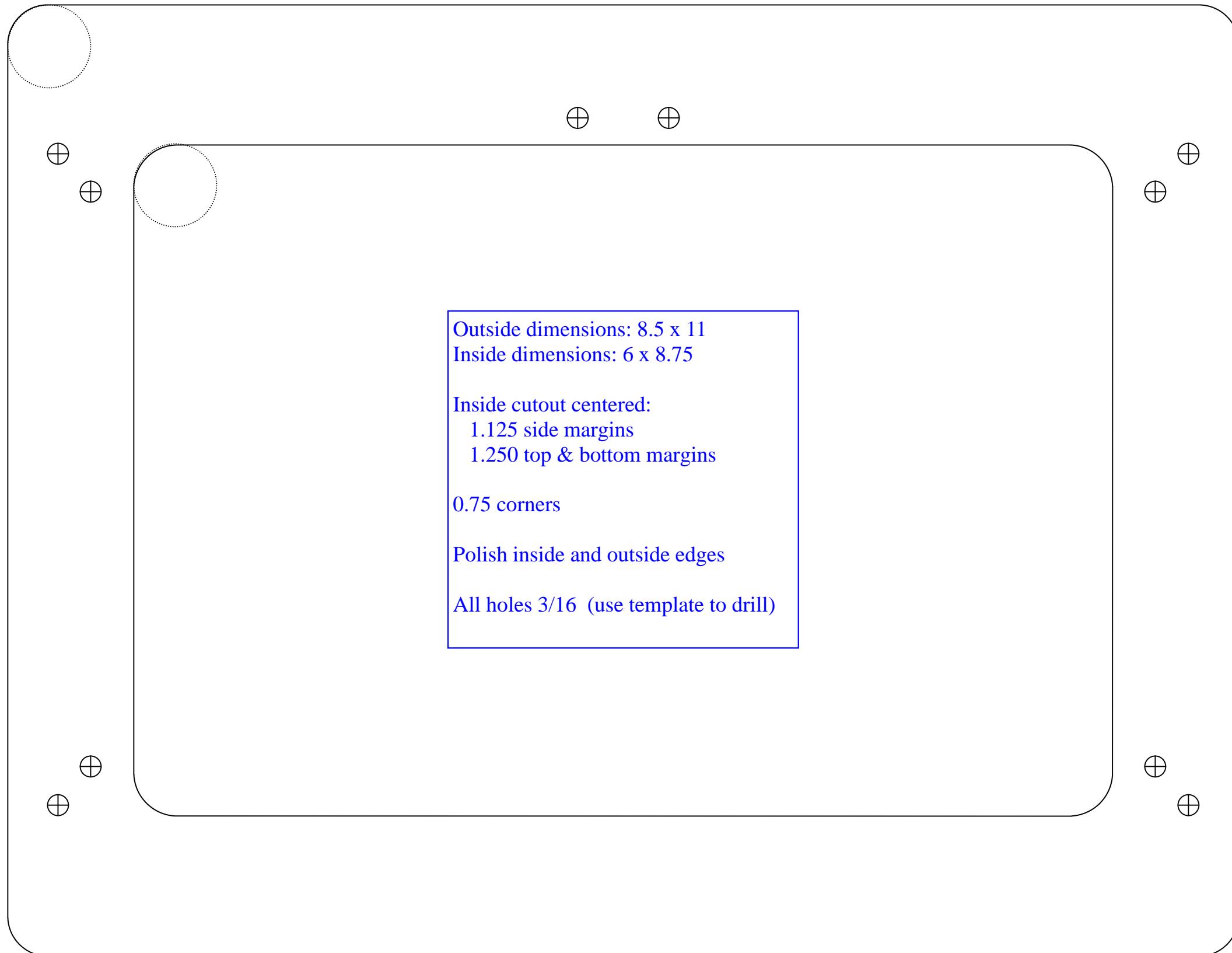
Reset

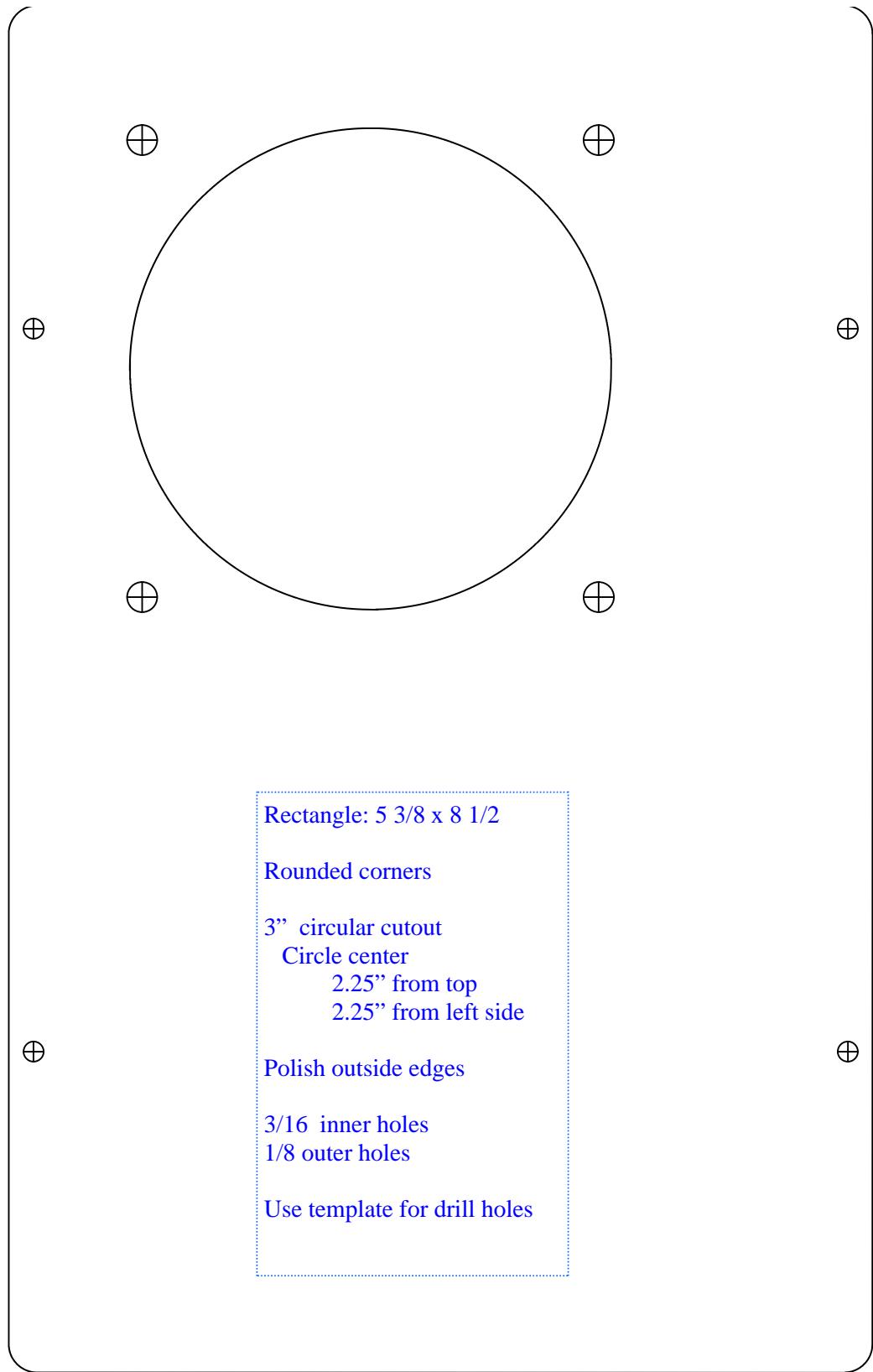
LEDs

Clock Source	SW1	SW2
Alternate	Closed	Closed
3 Mhz	Open	Closed
Variable	Closed	Open
Single Step	Open	Open





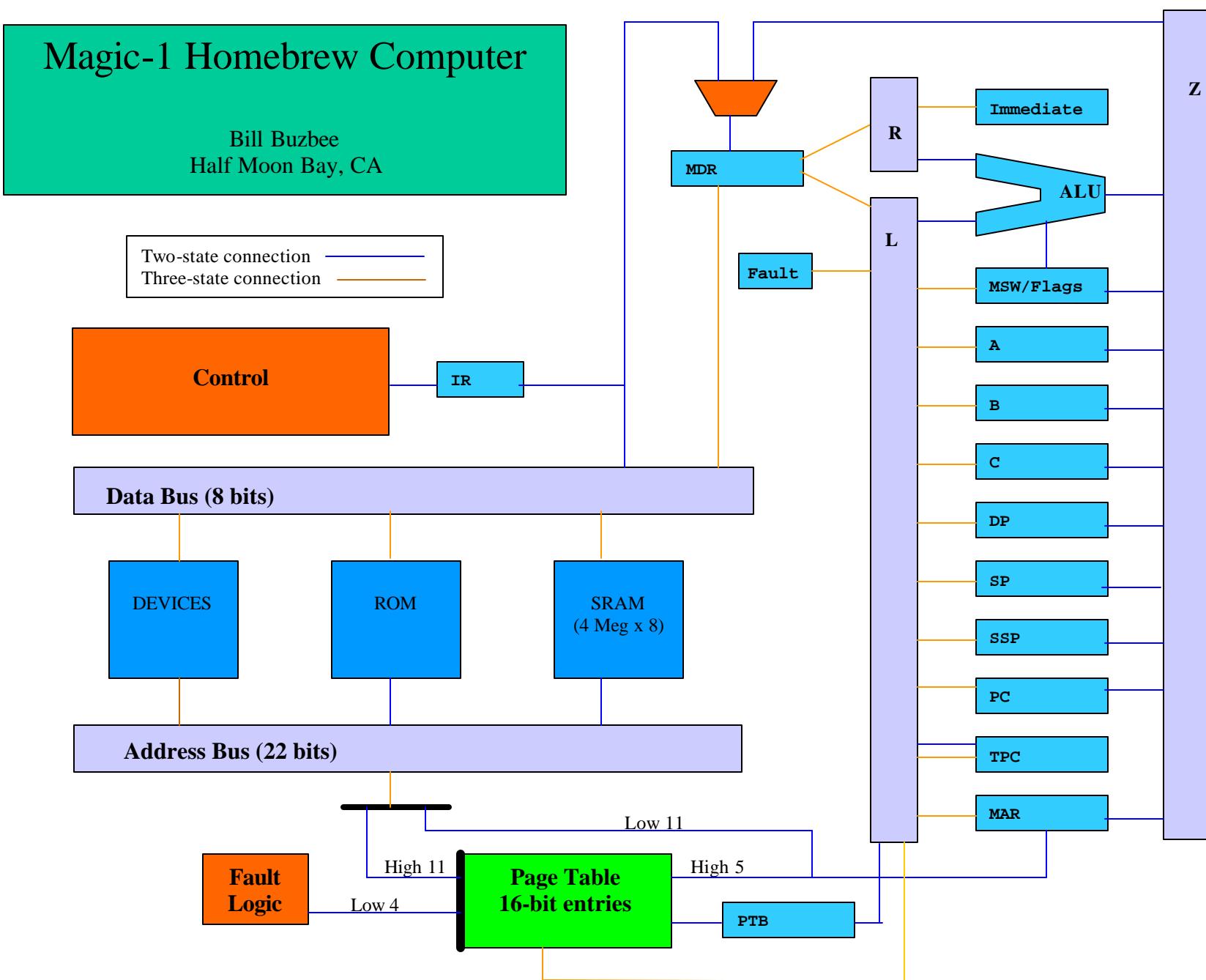




Magic-1 Homebrew Computer

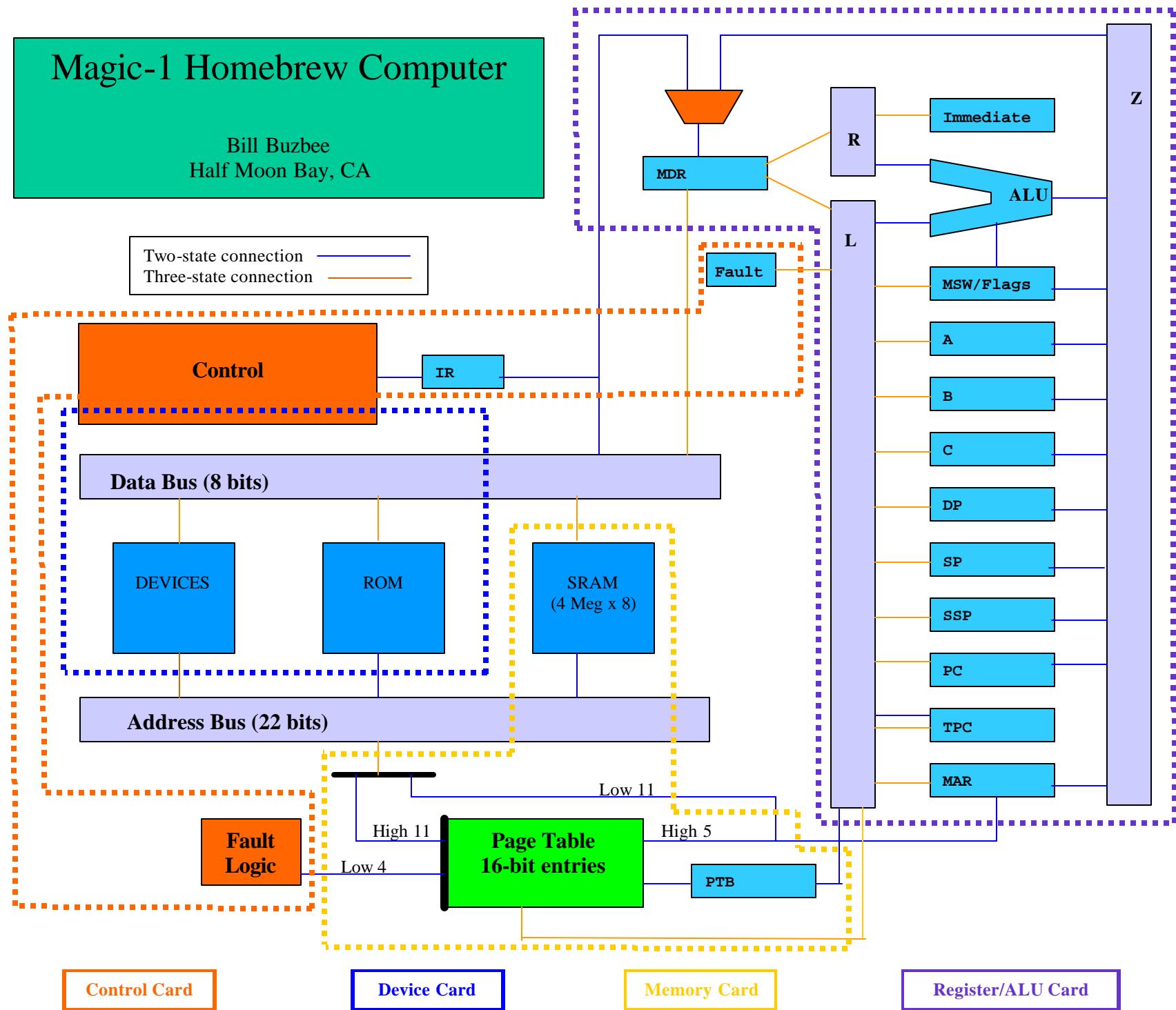
Bill Buzbee
Half Moon Bay, CA

Two-state connection —————
Three-state connection ——————



Magic-1 Homebrew Computer

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1

2

3

4

5

6

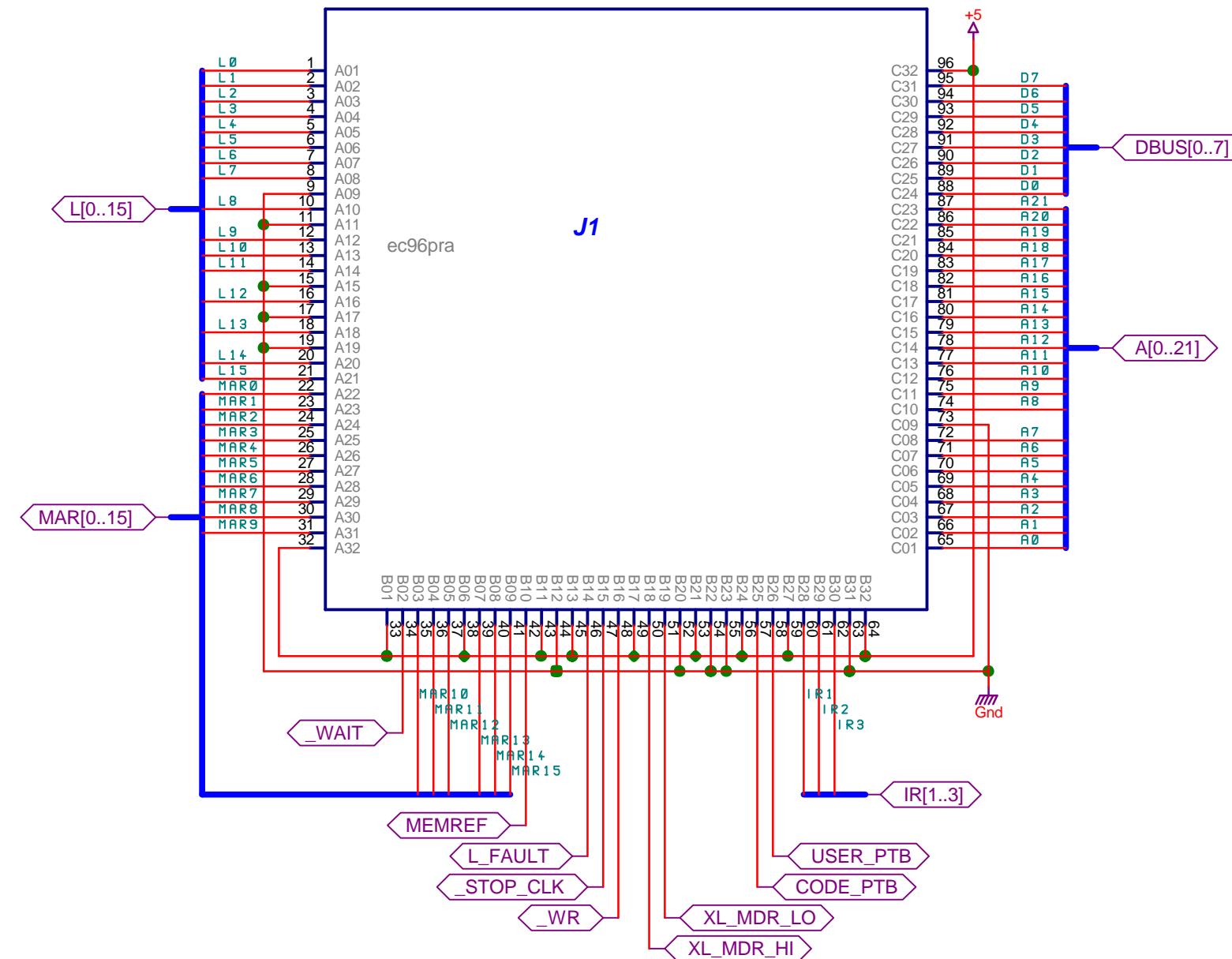
7

8

A**B****C****D****E****F****G****H**

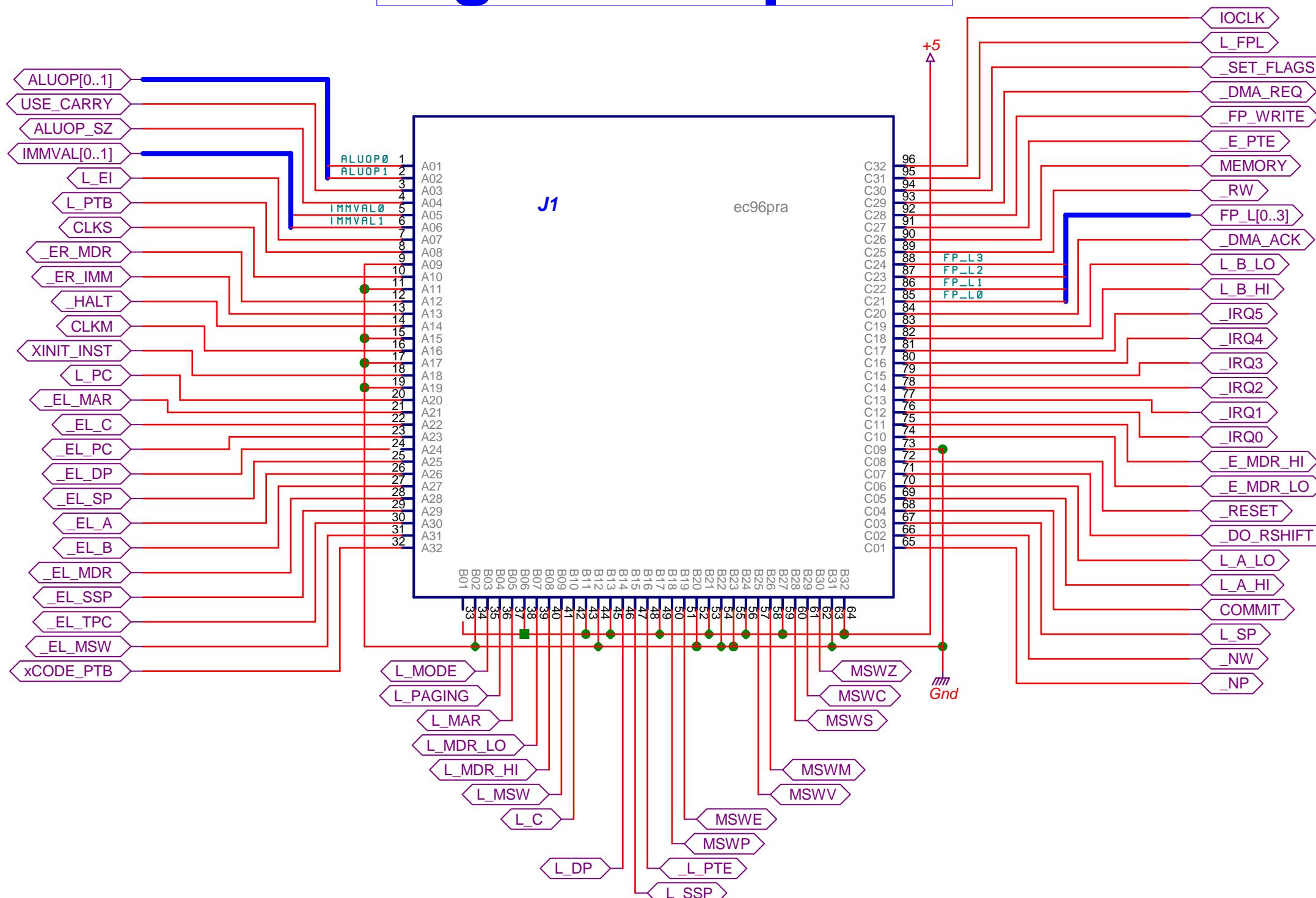
Left Backplane

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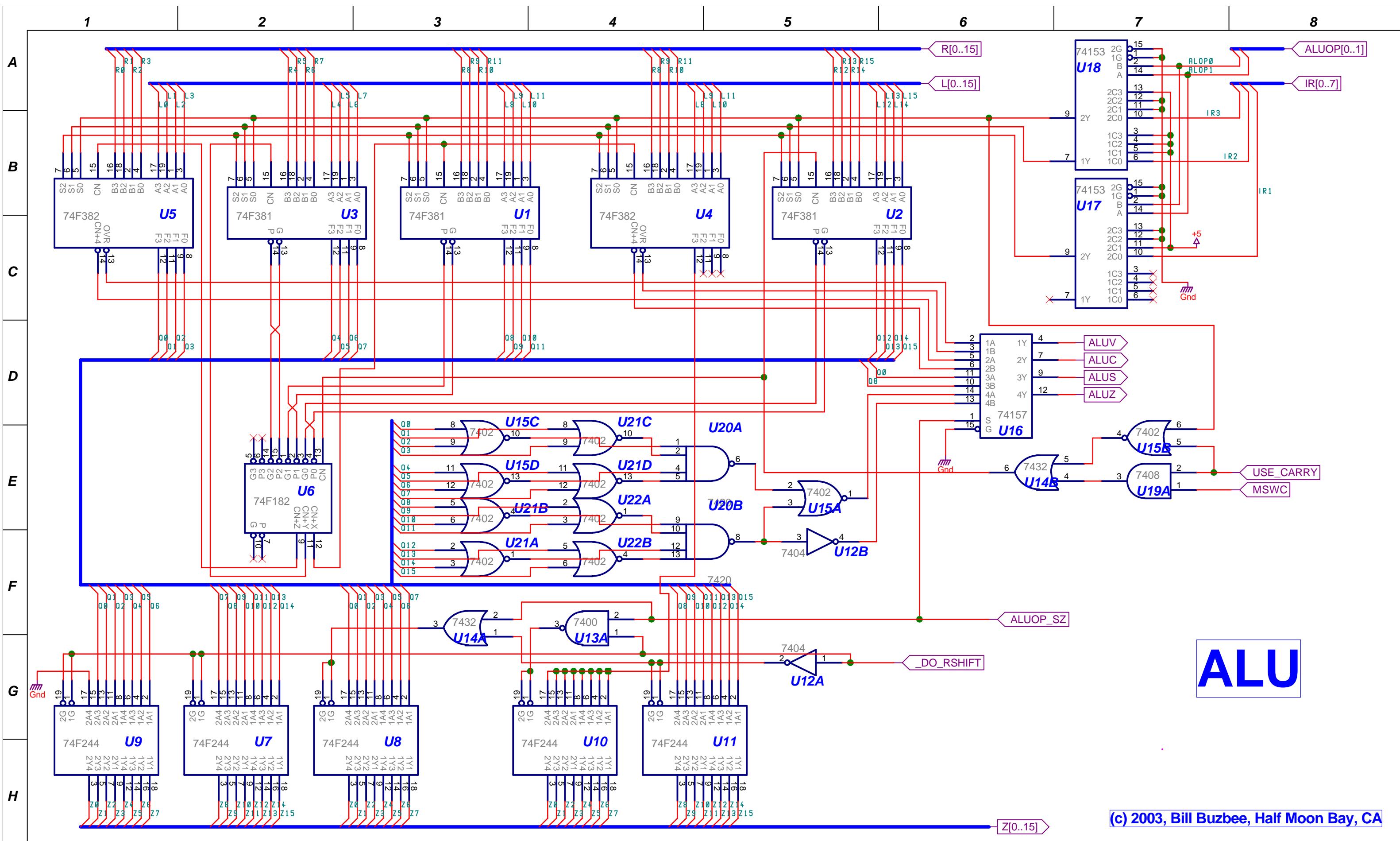
A
B
C
D
E
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H

Right Backplane



Register/ALU Card



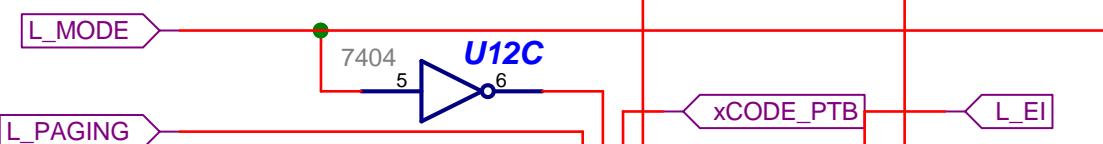


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A

MSW

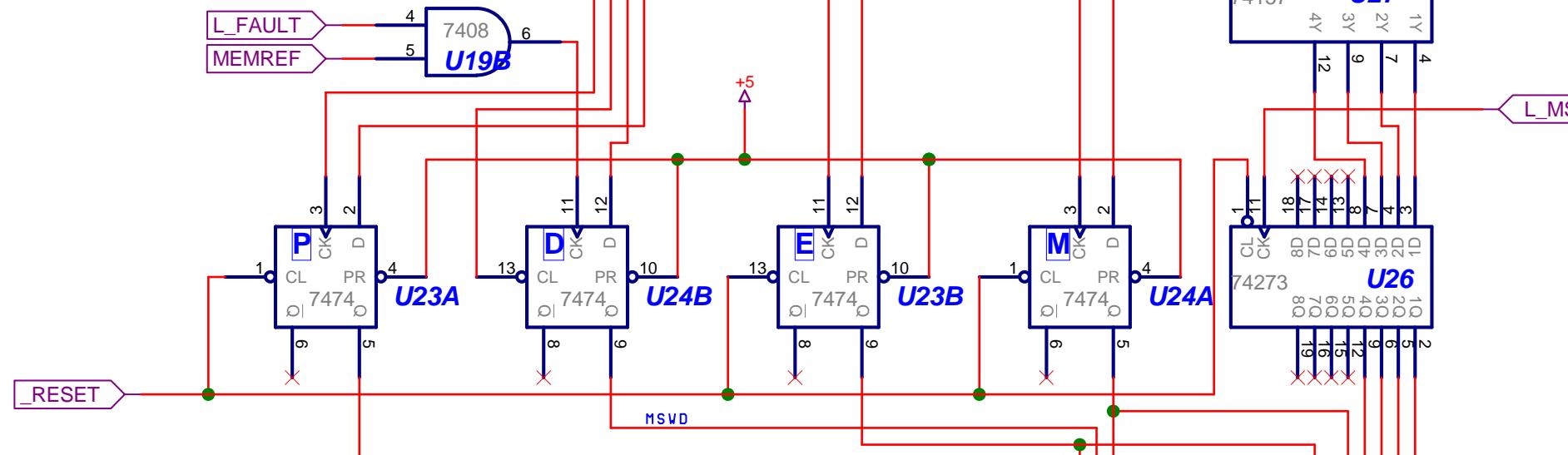
B



C

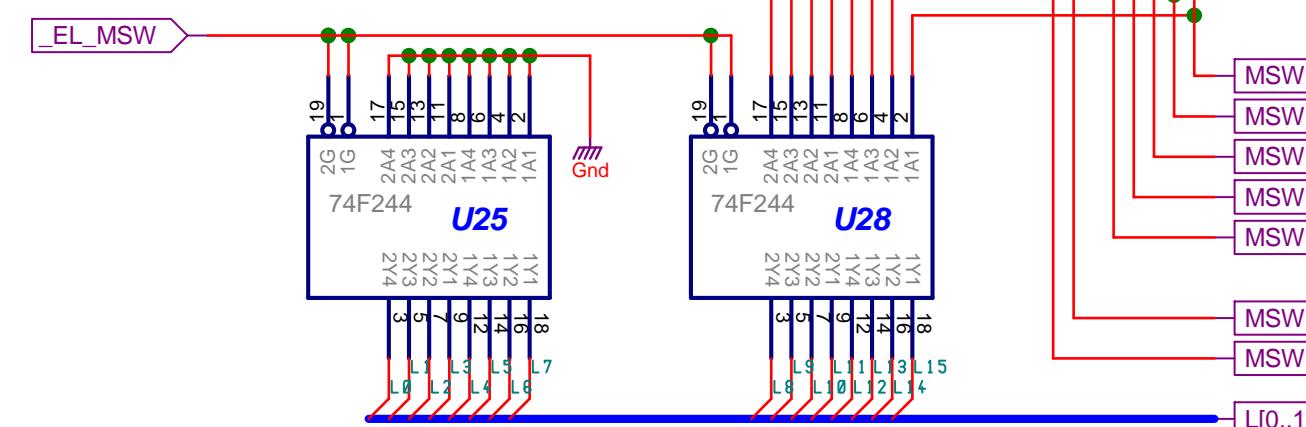
L_FAULT → 7408 → U19B
MEMREF → 7408 → U19B

D



E

F



G

H

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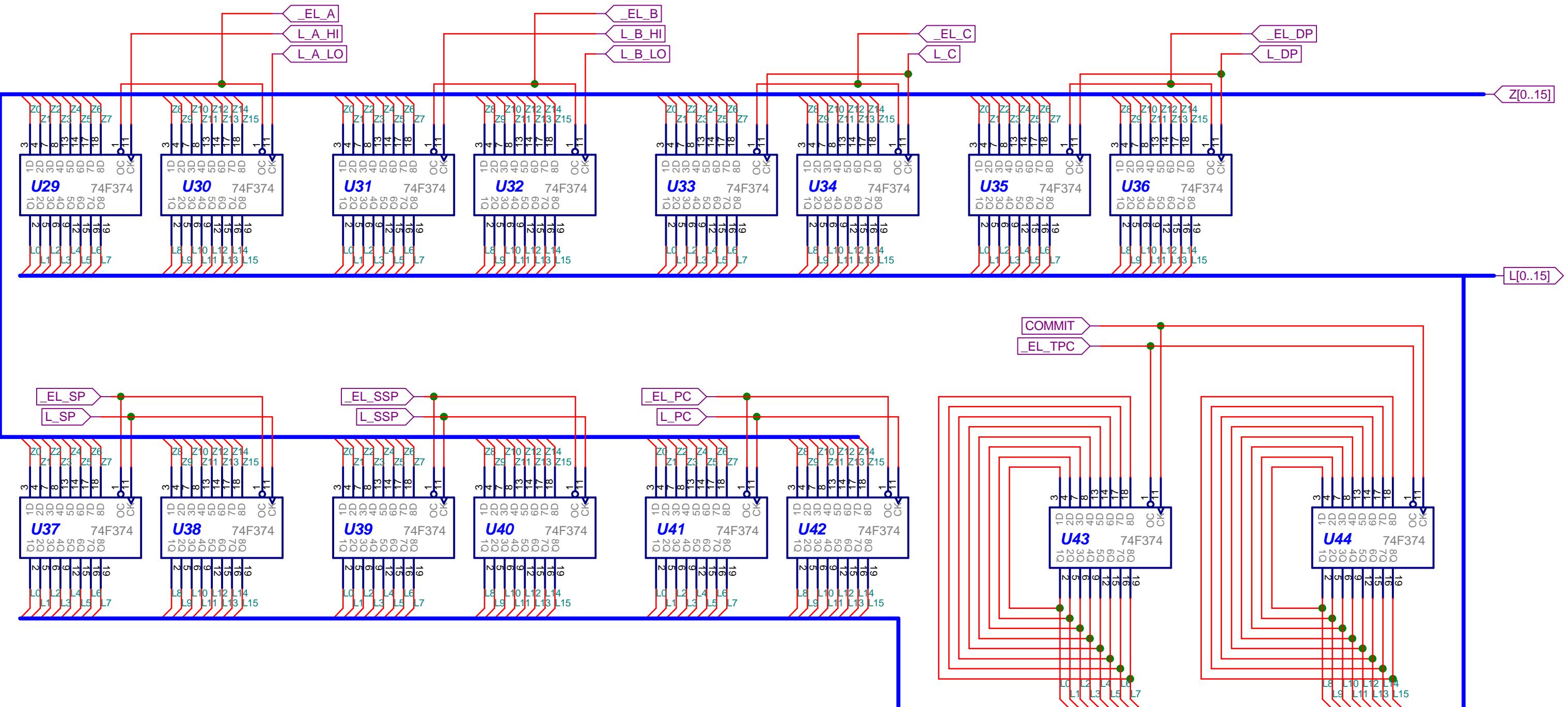
6

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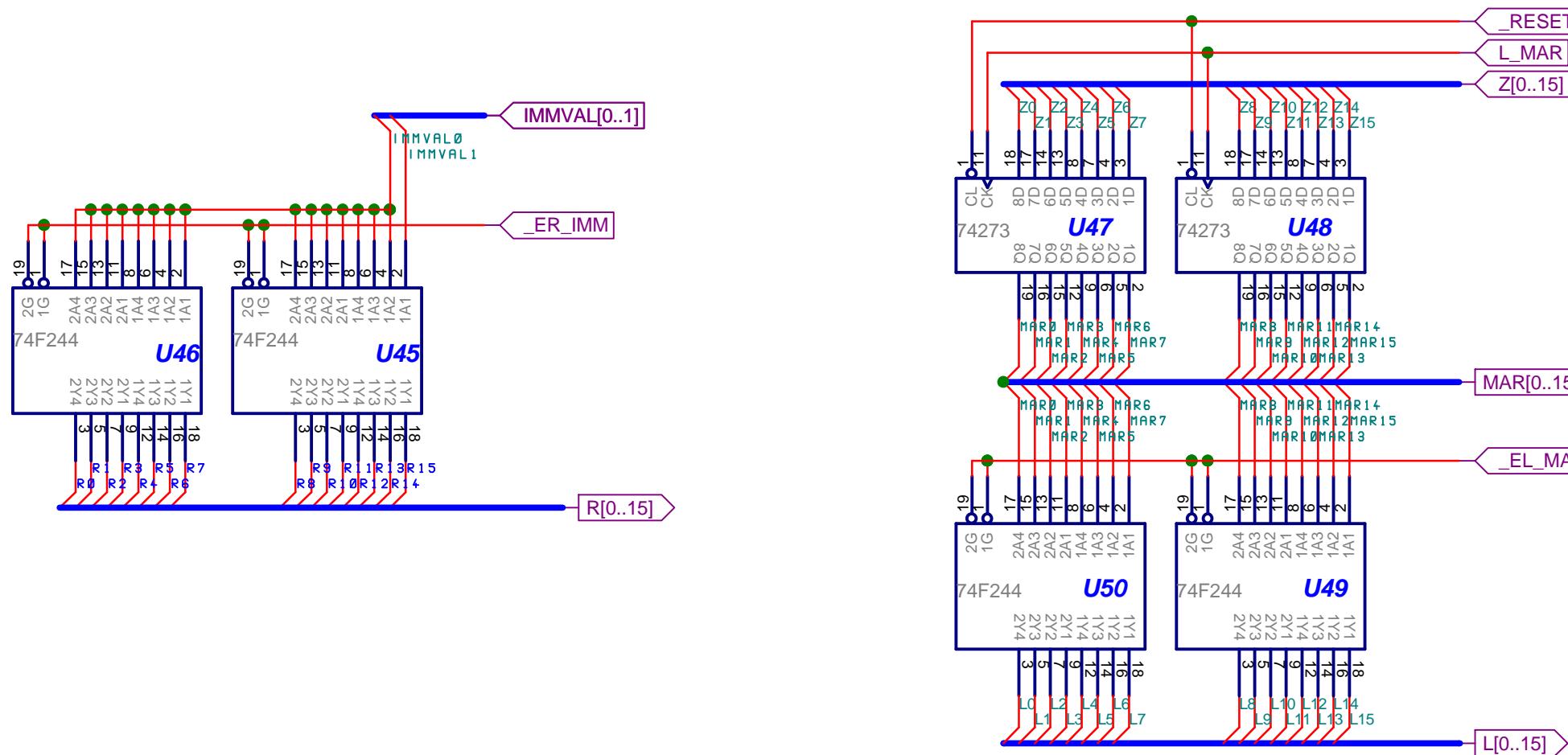
A**B****C****D****E****F****G****H**

General Registers



A**B****C****D****E****F****G****H**

Special Registers



1 2 3 4 5 6 7 8

A

MDR

B

C

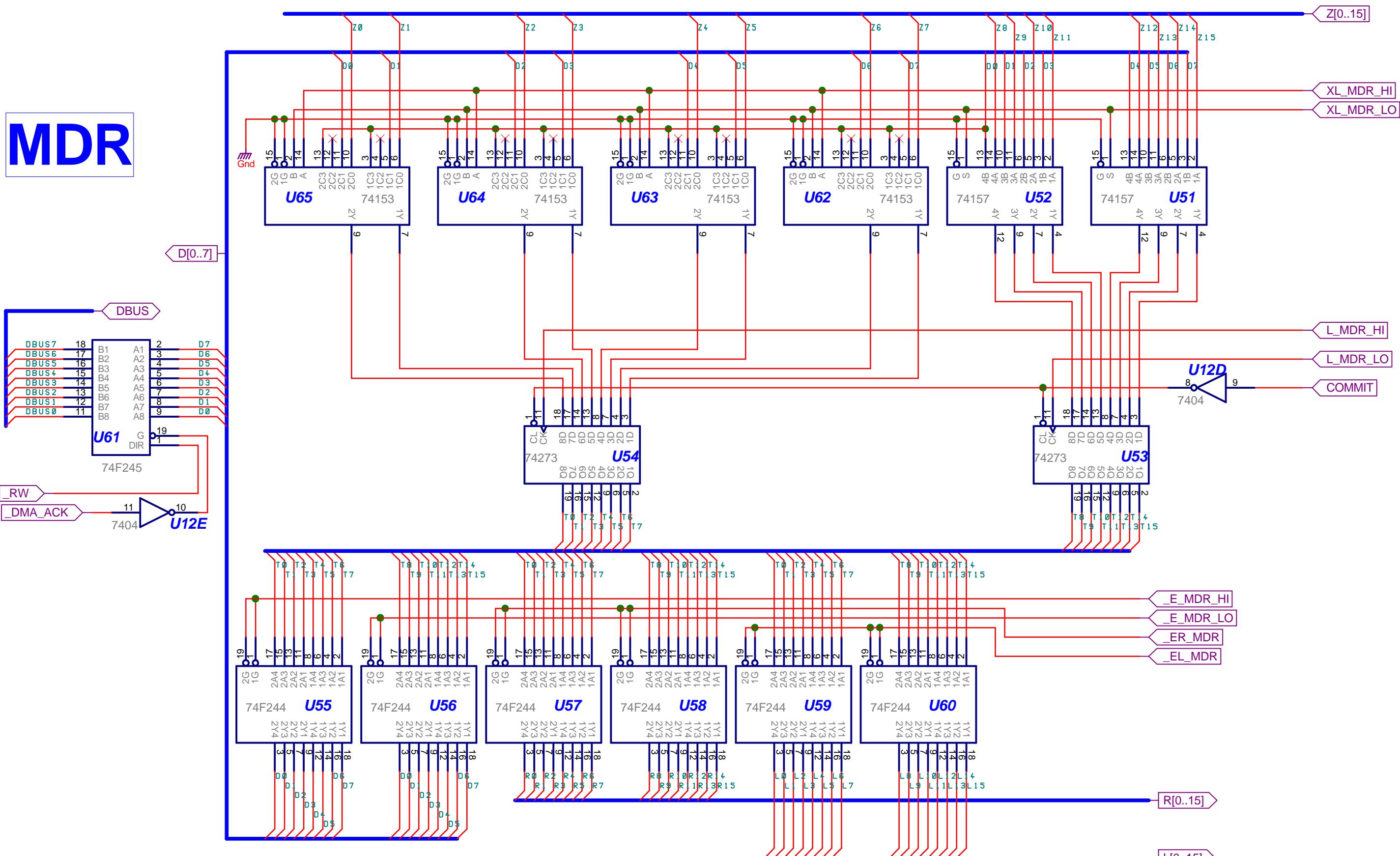
D

E

F

G

H



Register card BOM

Item	Qty	References	Value
1	1	U13	7400
2	3	U15,U21,U22	7402
3	1	U12	7404
4	1	U19	7408
5	1	U20	7420
6	1	U14	7432
7	2	U23,U24	7474
8	6	U17,U18,U62,U63,U64,U65	74153
9	4	U16,U27,U51,U52	74157
10	5	U26,U47,U48,U53,U54	74273
11	1	U6	74F182
12	17	U7,U8,U9,U10,U11,U25,U28,U45,U46,U49,U50,U55,U56, U57,U58,U59,U60	74F244
13	1	U61	74F245
14	16	U29,U30,U31,U32,U33,U34,U35,U36,U37,U38,U39,U40,U41, U42,U43,U44	74F374
15	3	U1,U2,U3	74F381
16	2	U4,U5	74F382

Control Card



1 2 3 4 5 6 7 8

A

Microcode

B

IR₀ IR₁ IR₂ IR₃ IR₄ IR₅ IR₆ IR₇ DBUS_{0..7} INIT_INST FAULT_PENDING

C

NEXT_{0..7} ENCODER_{0..3} IR_{0..7} _NEXT_{0..7}

D

U15 U16 U17 U18 U19

E

U1 U2 U3 U4 U5

F

RESET CLKM

U10 U9 U8 U7 U6

G

CODE_PTB RUSER_PTB

EL_{0..3} ER_{0..1}

IMMVAL_{0..1}

RIMMVAL_{0..1}

MISC_{0..3}

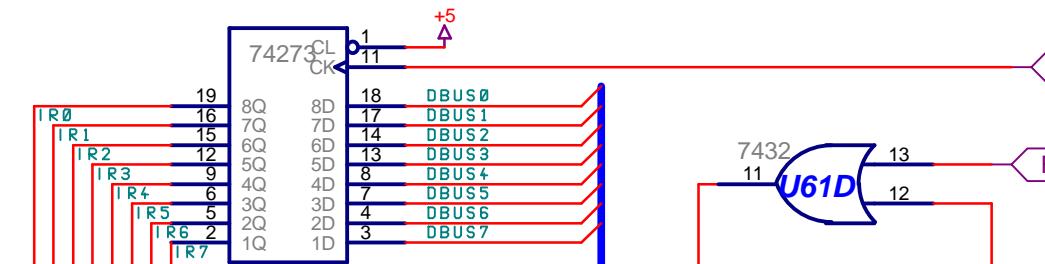
LATCH_SZ USE_CARRY

ALUOP_{0..1}

ALUOP_SZ

NEGATE_BR

ALUOP₀ ALUOP₁



DBUS[0..7]

FAULT_PENDING

INIT_INST

IR[0..7]

ENCODER[0..3]

NEXT{0..7}

NEXT_{0..7}

NEXT_{1..7}

NEXT_{2..7}

NEXT_{3..7}

NEXT_{4..7}

NEXT_{5..7}

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NEXT_{7..13}

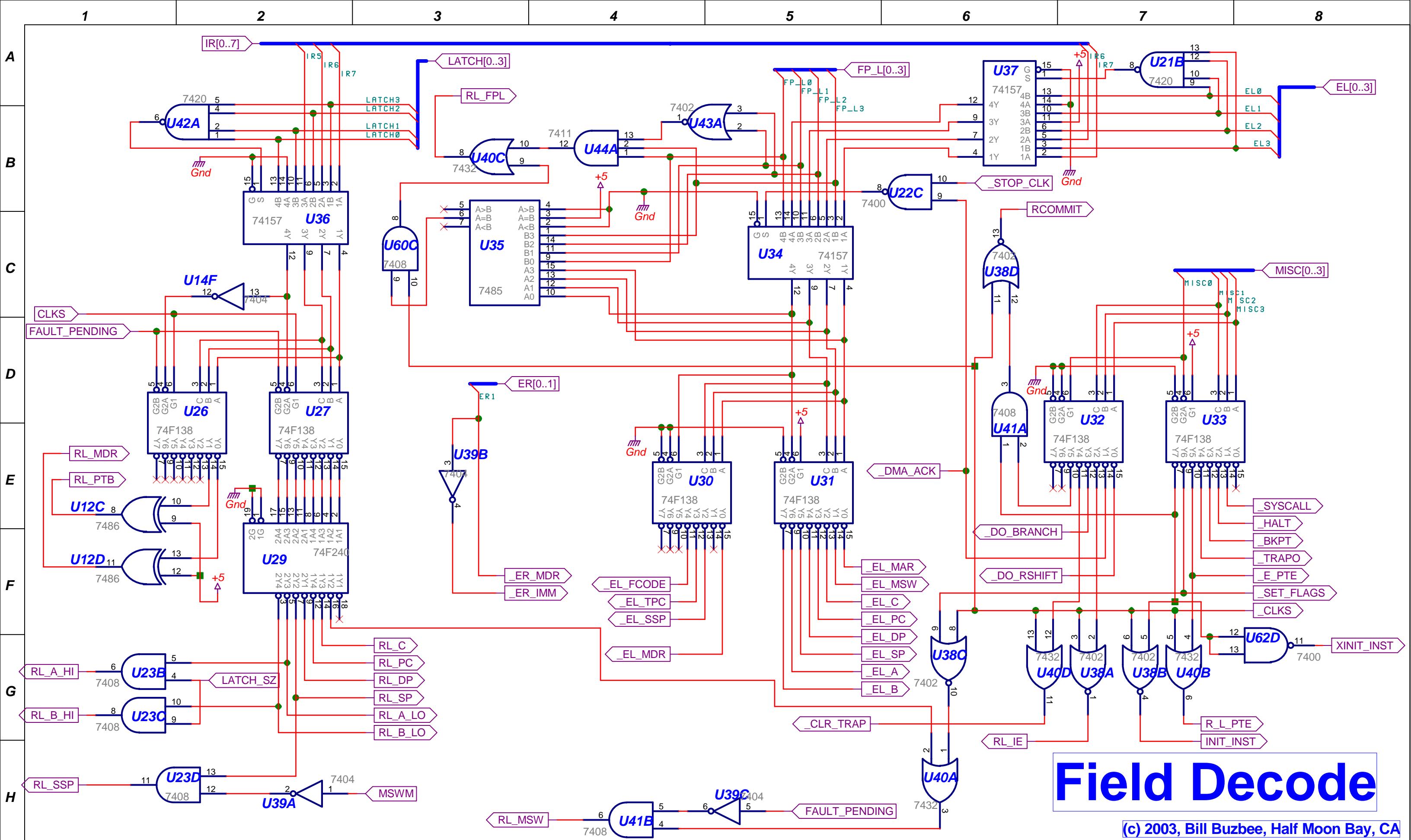
NEXT_{8..13}

NEXT_{9..13}

NEXT_{10..13}

NEXT_{11..13}

NEXT_{12..13}</p



1

2

3

4

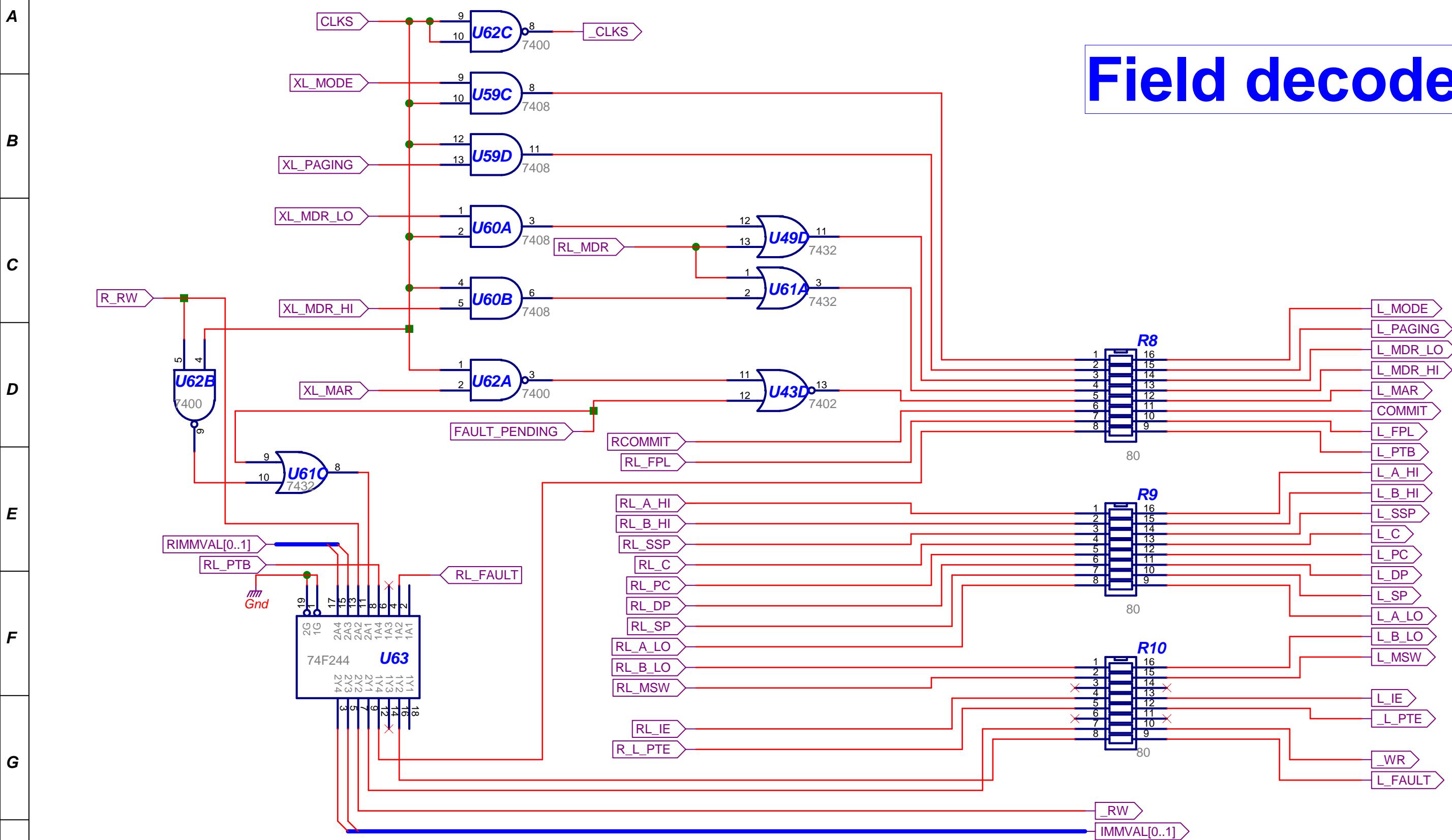
5

6

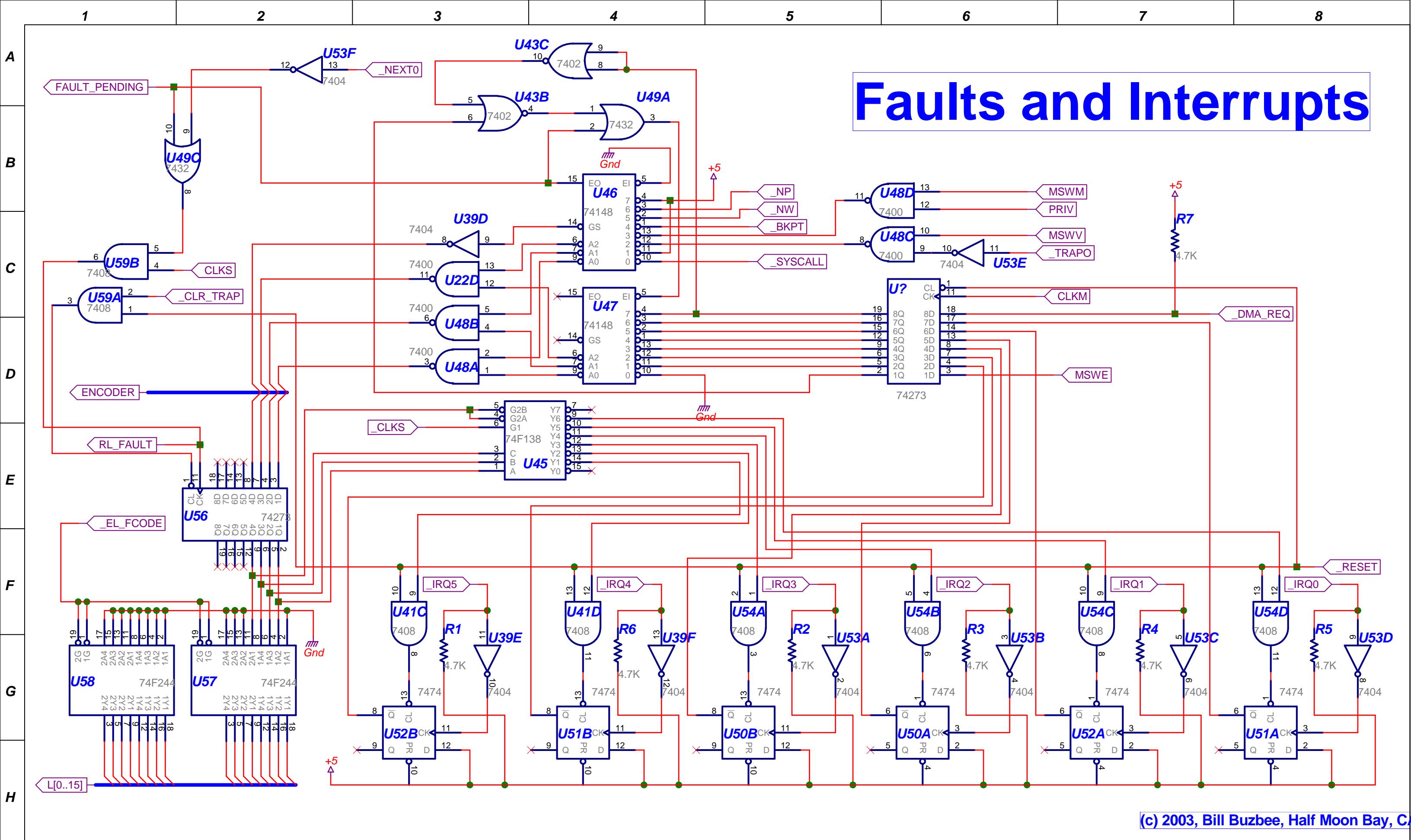
7

8

Field decode 2



Faults and Interrupts

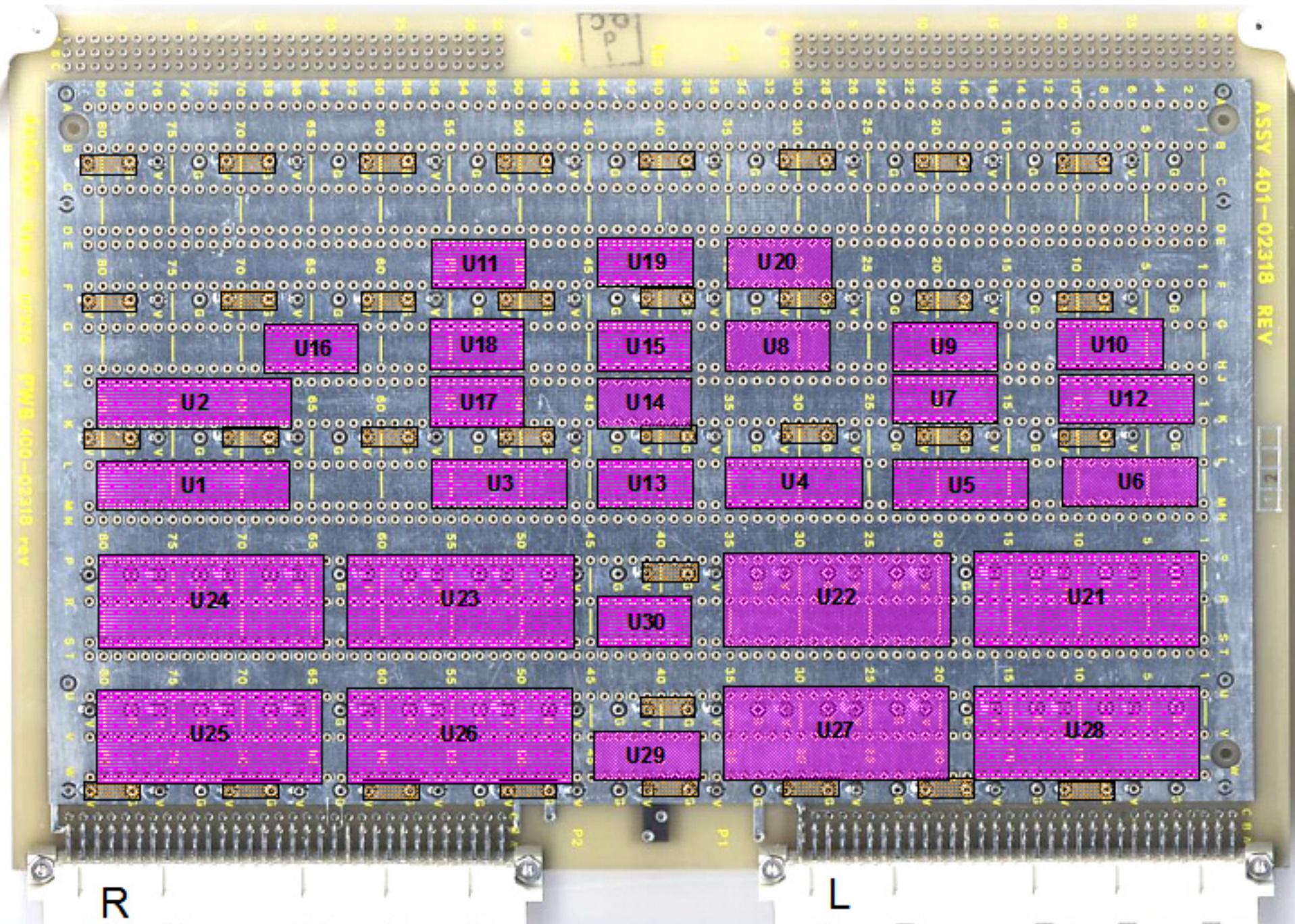


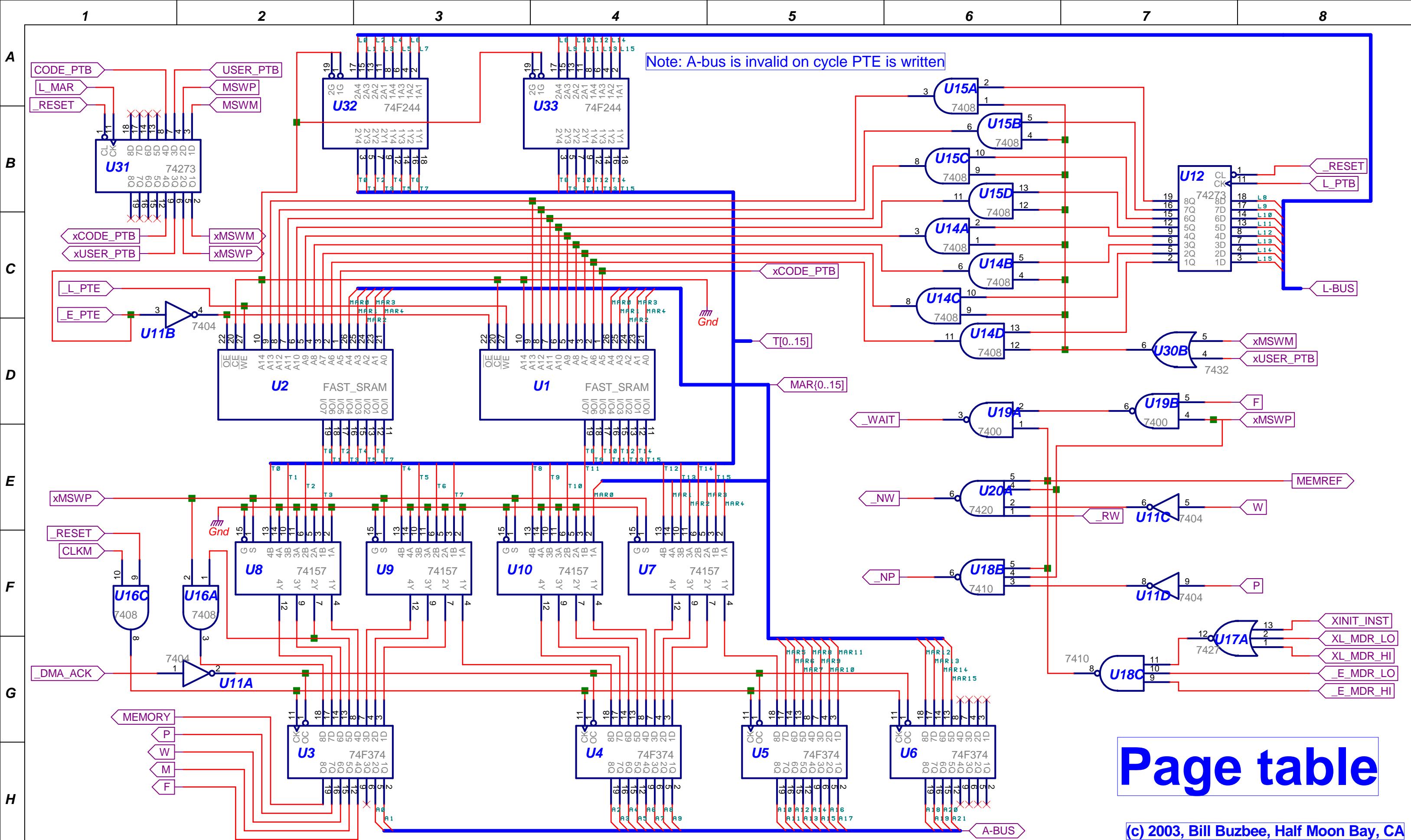
Control card BOM

Item	Qty	References	Value
1	3	R8,R9,R10	80
2	7	R1,R2,R3,R4,R5,R6,R7	4.7K
3	3	U22,U48,U62	7400
4	3	U20,U38,U43	7402
5	3	U14,U39,U53	7404
6	5	U23,U41,U54,U59,U60	7408
7	1	U25	7410
8	1	U44	7411
9	2	U21,U42	7420
10	1	U24	7430
11	4	U13,U40,U49,U61	7432
12	4	U50,U51,U52,U55	7474
13	1	U35	7485
14	1	U12	7486
15	2	U46,U47	74148
16	1	U11	74151
17	4	U15,U16,U17,U18	74153
18	3	U34,U36,U37	74157
19	7	U6,U7,U8,U9,U10,U19,U56	74273
20	7	U26,U27,U30,U31,U32,U33,U45	74F138
21	1	U29	74F240
22	3	U57,U58,U63	74F244
23	5	U1,U2,U3,U4,U5	74S472

Note: U64 and U28 deleted

Memory Card





1

2

3

4

5

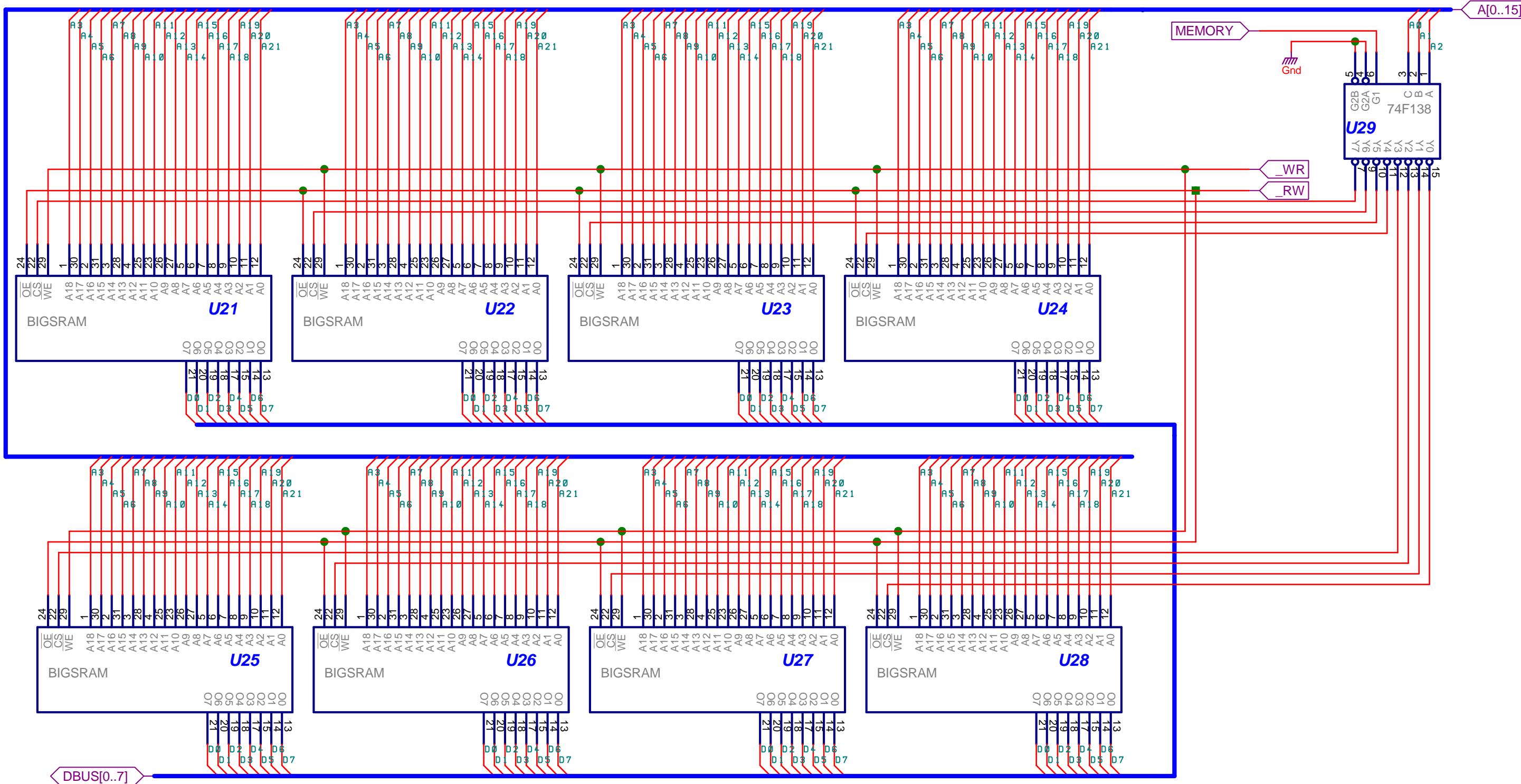
6

7

8

SRAM

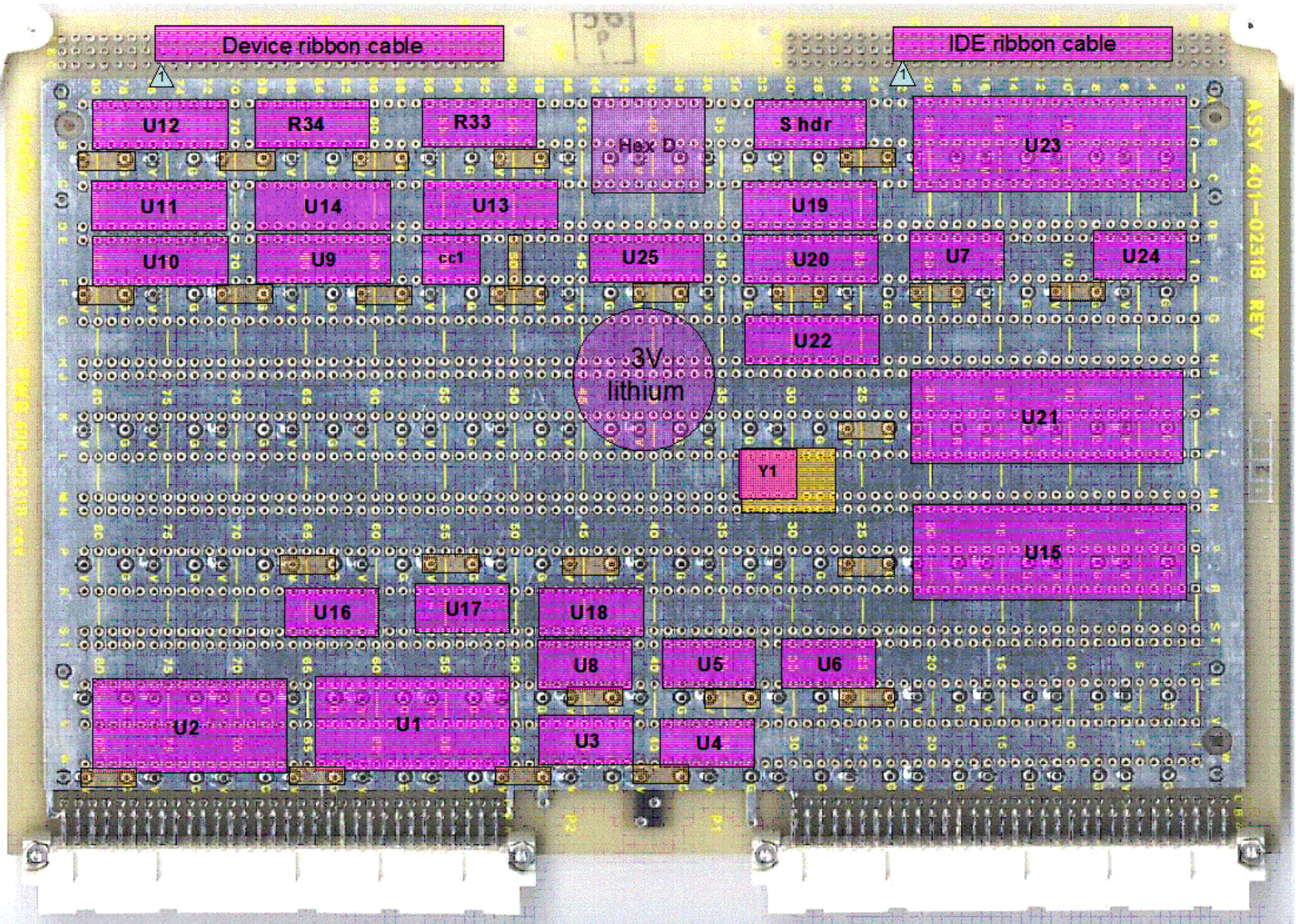
A
B
C
D
E
F
G
H



Bill of materials -- Memory Card --- page 1

Item	Qty	References	Value
1	1	U19	7400
2	1	U13	7402
3	1	U11	7404
4	3	U14,U15,U16	7408
5	1	U18	7410
6	1	U20	7420
7	1	U17	7427
8	1	U30	7432
9	4	U7,U8,U9,U10	74157
10	1	U12	74273
11	1	U29	74F138
12	4	U3,U4,U5,U6	74F374
13	8	U21,U22,U23,U24,U25,U26,U27,U28	BIGSRAM
14	2	U1,U2	FAST_SRAM

Device Card

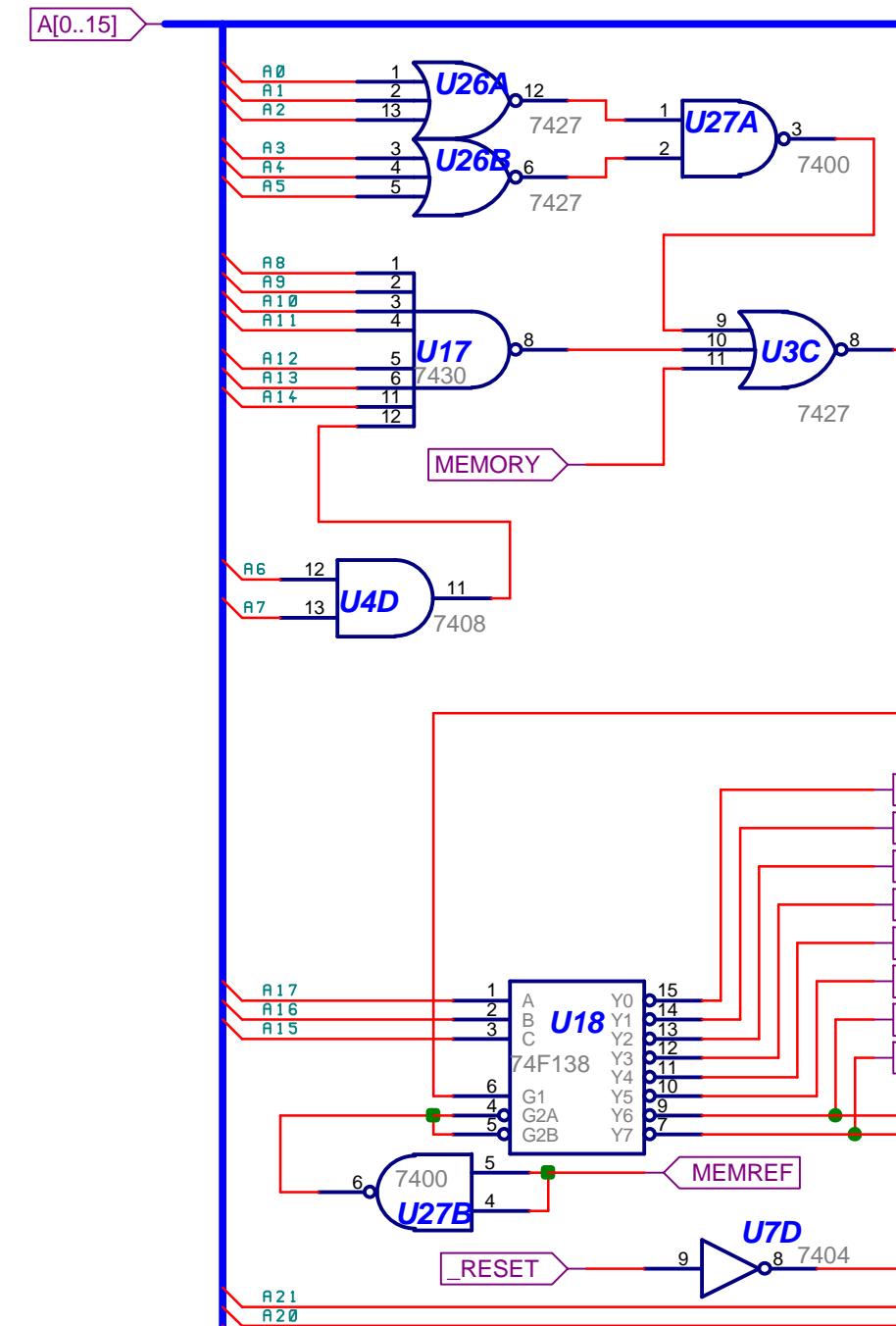


cc1 -> component carrier for D20, D21, R35

1 2 3 4 5 6 7 8

A

UARTS



B

C

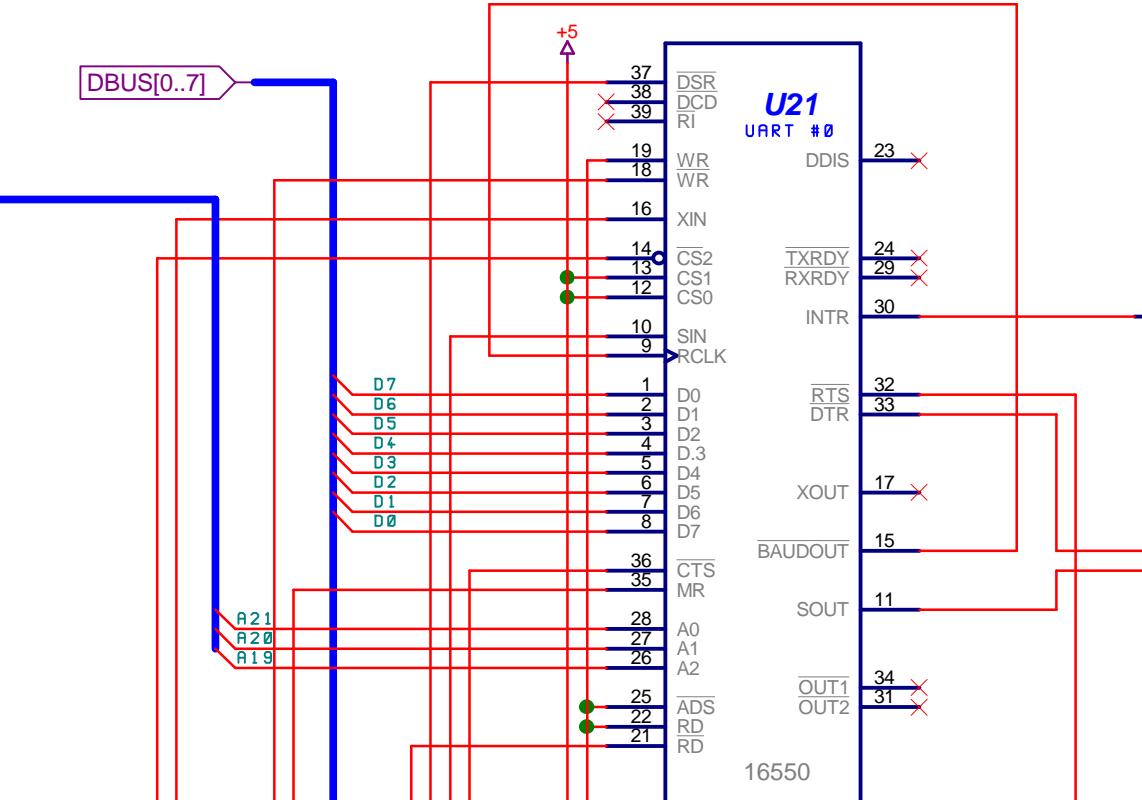
D

E

F

G

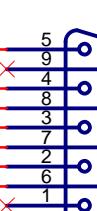
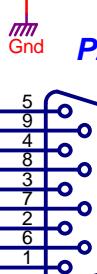
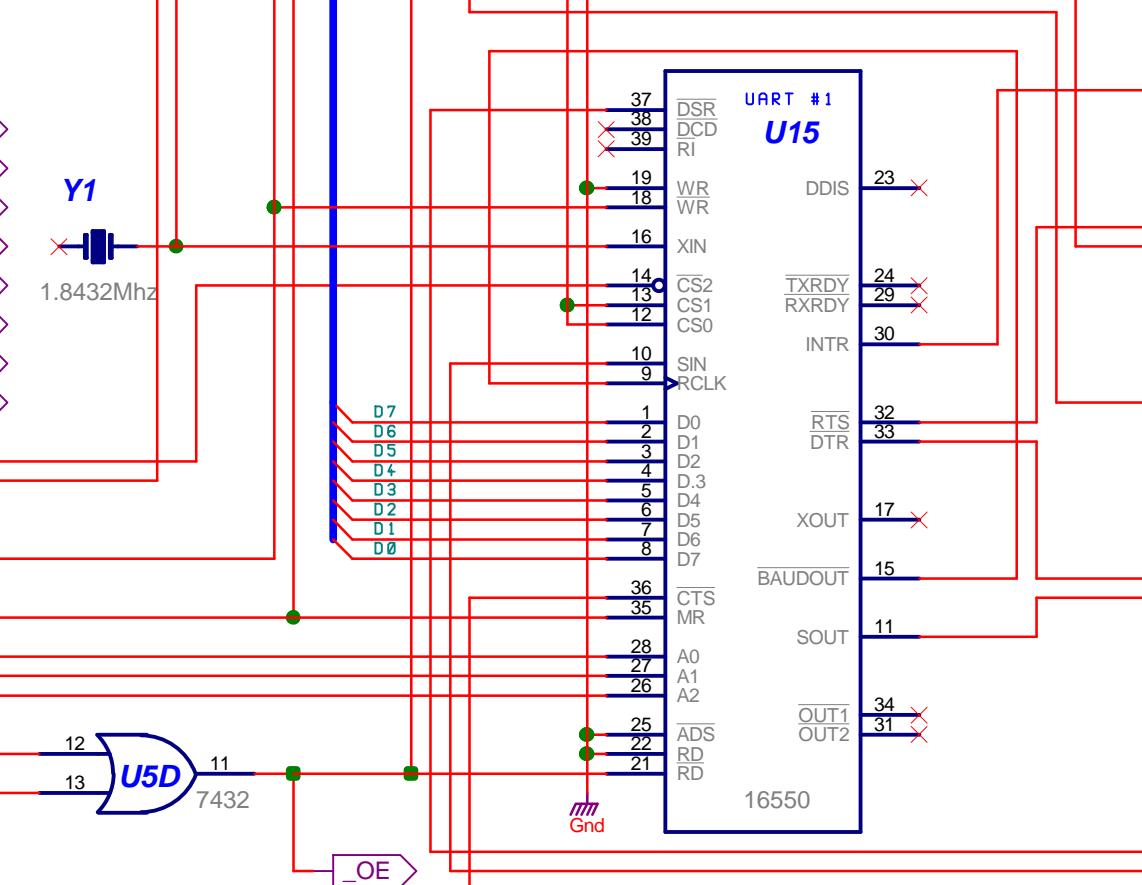
H



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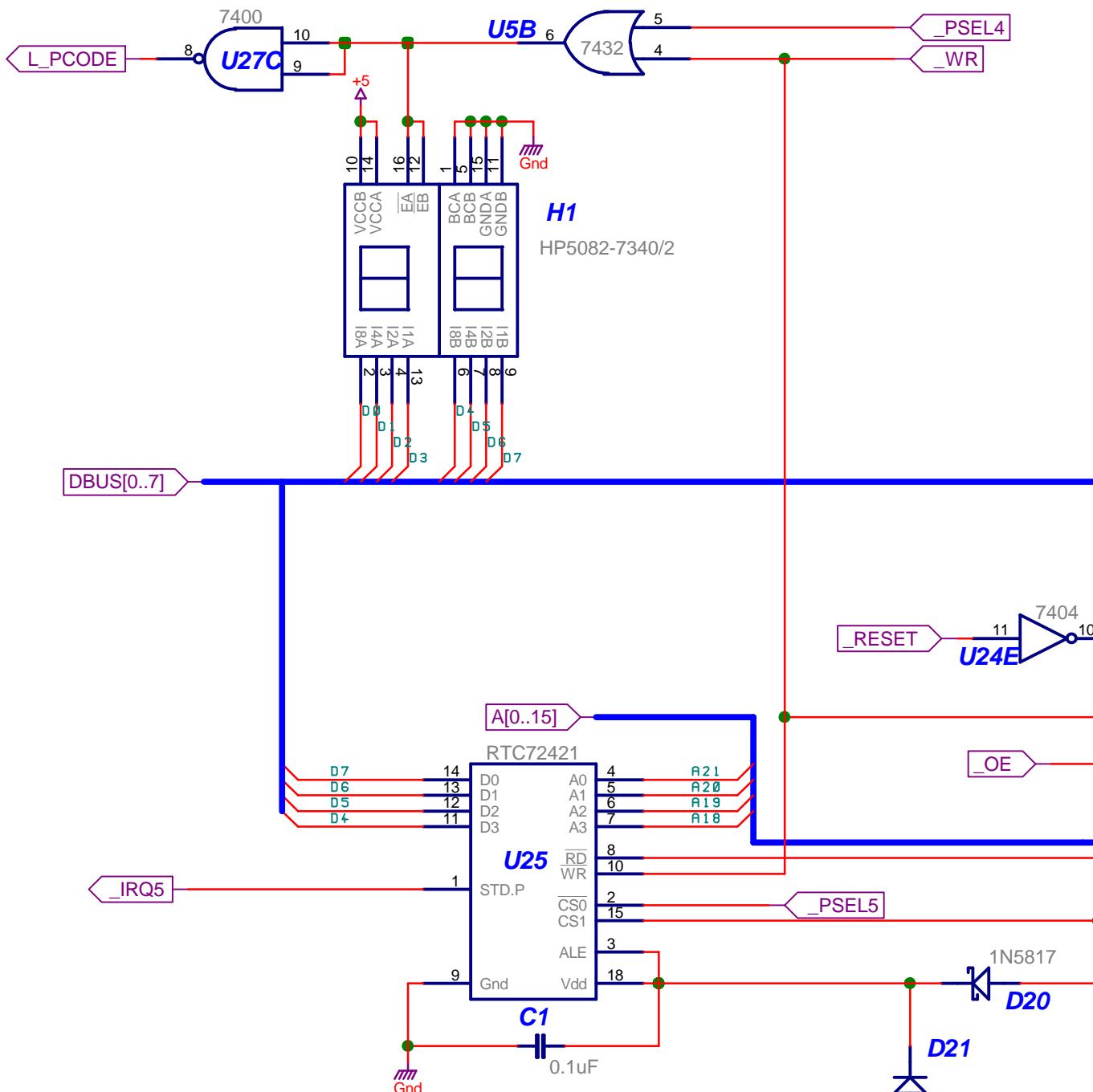
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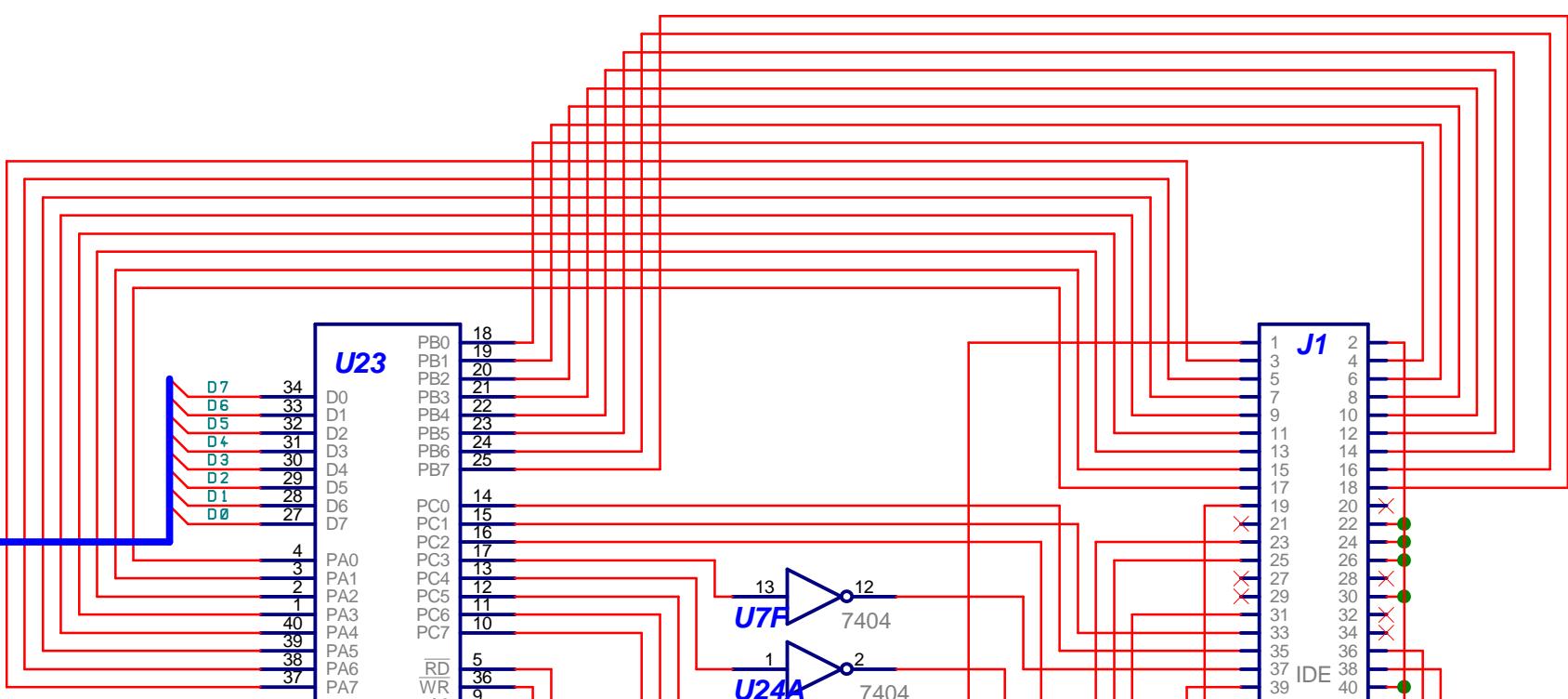
8

A

POST Display



IDE Interface

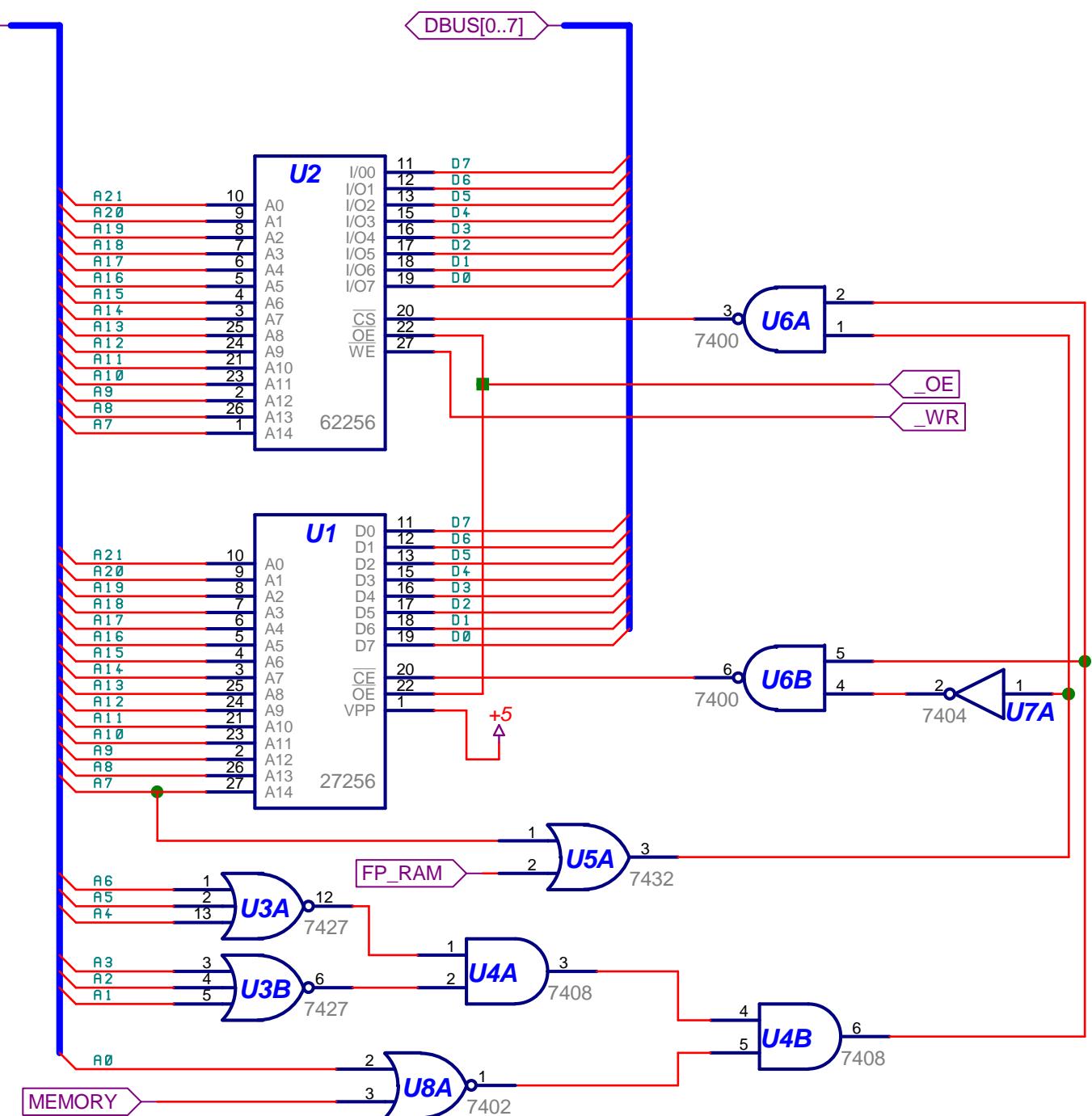


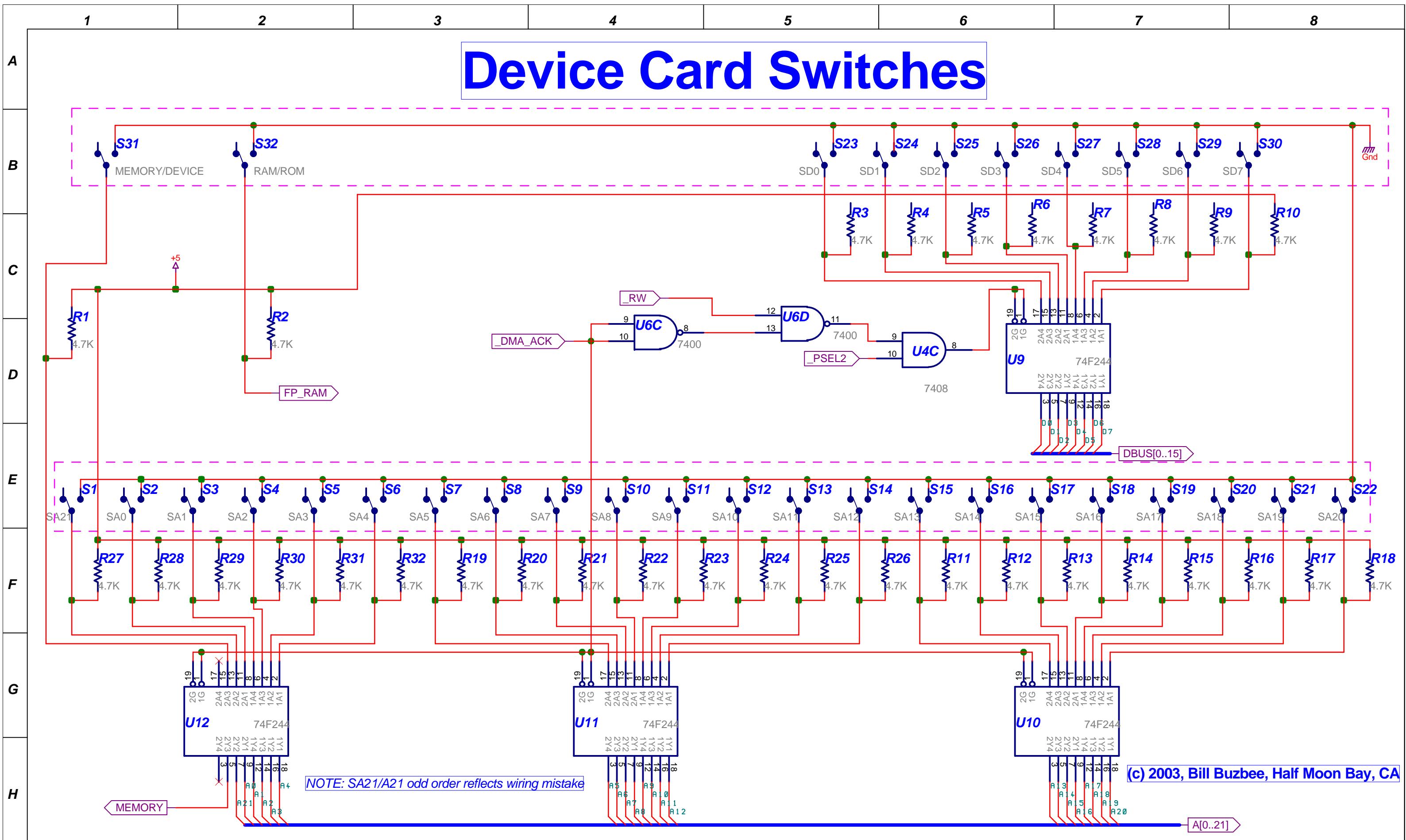
Real time clock

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RAM & ROM

A
B
C
D
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H

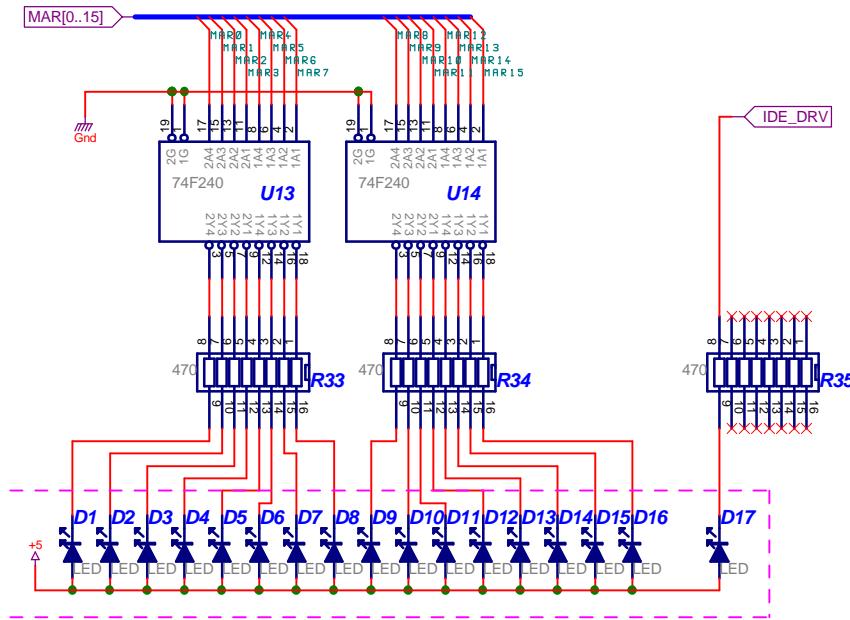




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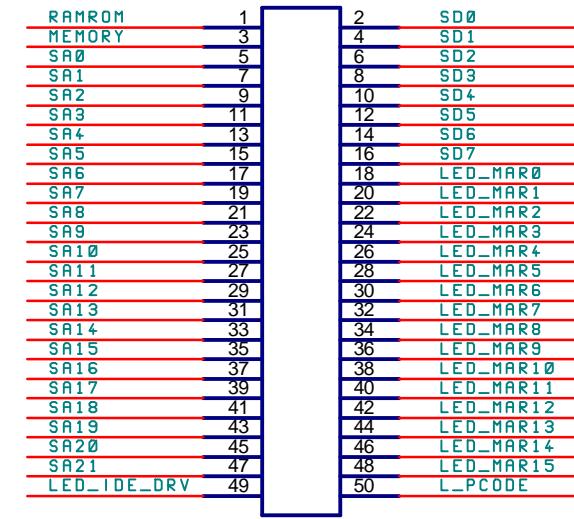
A**B****C****D****E****F****G****H**

Device LED



A**B****C****D****E****F****G****H**

Device Ribbon Cable

Right**W1**

Ribbon50

Device BOM

Item	Qty	References	Value
1	3	R33,R34,R35	470
2	1	J1	IDE
3	17	D1,D2,D3,D4,D5,D6,D7,D8,D9,D10,D11,D12,D13, D14,D15,D16,D17	LED
4	1	S2	SA1
5	1	S3	SA2
6	1	S4	SA3
7	1	S5	SA4
8	1	S6	SA5
9	1	S7	SA6
10	1	S8	SA7
11	1	S9	SA8
12	1	S10	SA9
13	1	S1	SAO
14	1	S23	SD0
15	1	S24	SD1
16	1	S25	SD2
17	1	S26	SD3
18	1	S27	SD4
19	1	S28	SD5
20	1	S29	SD6
21	1	S30	SD7
22	32	R1,R2,R3,R4,R5,R6,R7,R8,R9,R10,R11,R12,R13, R14,R15,R16,R17,R18,R19,R20,R21,R22,R23,R24, R25,R26,R27,R28,R29,R30,R31,R32	4.7K
23	2	U6,U27	7400
24	1	U8	7402
25	2	U7,U24	7404
26	1	U4	7408
27	1	U3,U26	7427
28	2	U16,U17	7430
29	1	U5	7432
30	1	U23	8255
31	1	S12	SA11
32	1	S13	SA12
33	1	S14	SA13
34	1	S15	SA14
35	1	S16	SA15
36	1	S17	SA16
37	1	S18	SA17
38	1	S19	SA18
39	1	S20	SA19
40	1	S11	SA10
41	1	S21	SA20
42	1	S22	SA21
43	1	C1	0.1uF
44	2	U15,U21	16550
45	1	U1	27256
46	1	U2	62256
47	1	D21	1N4148
48	1	D20	1N5817
49	1	U18	74F138
50	2	U13,U14	74F240
51	4	U9,U10,U11,U12	74F244
52	3	U19,U20,U22	MAX233
53	2	D18,D19	TIL311
54	1	S32	RAM/ROM
55	1	W1	Ribbon50
56	1	U25	RTC72421
57	1	Y1	1.8432Mhz

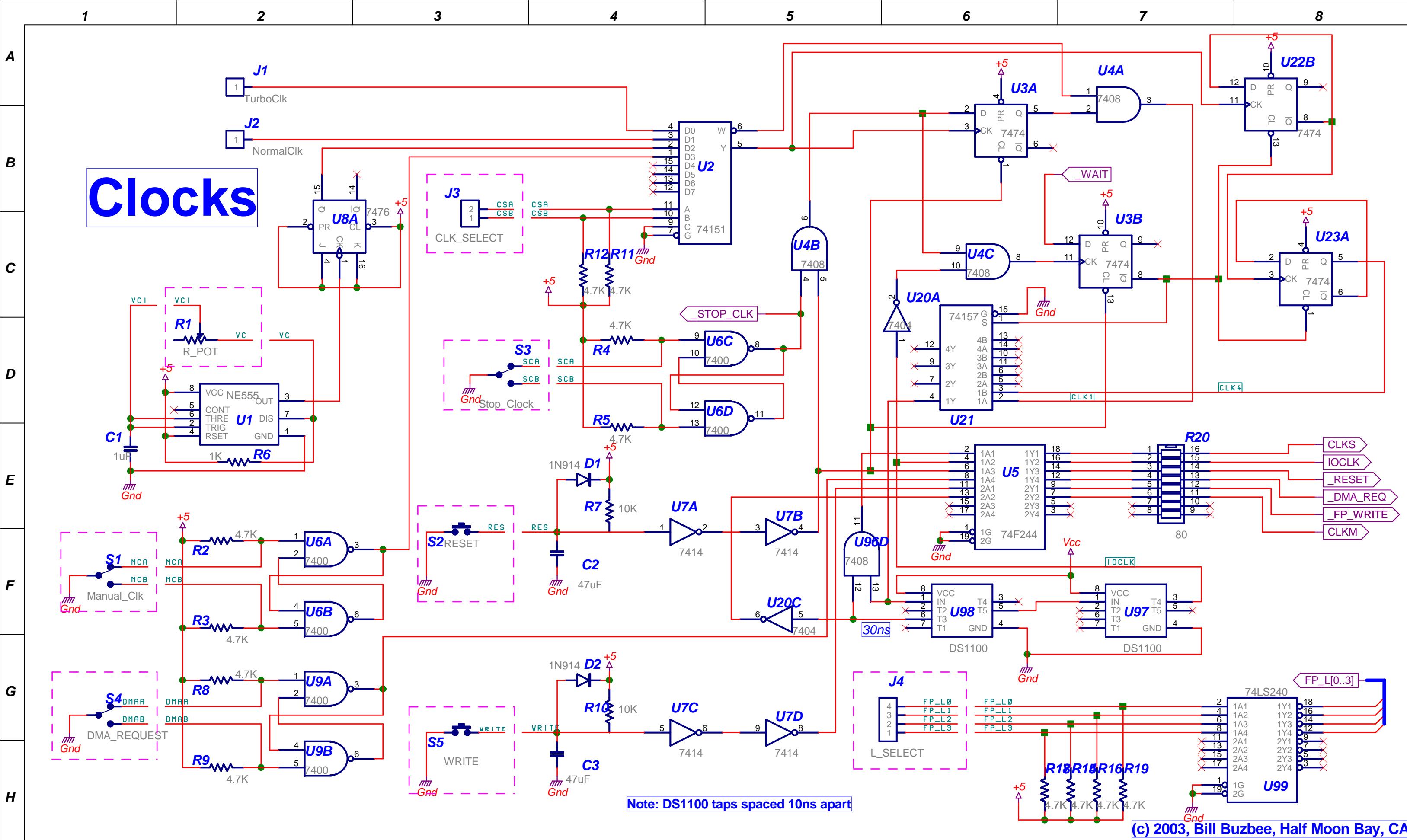
58 2 P1,P2
59 1 B1
60 1 S31

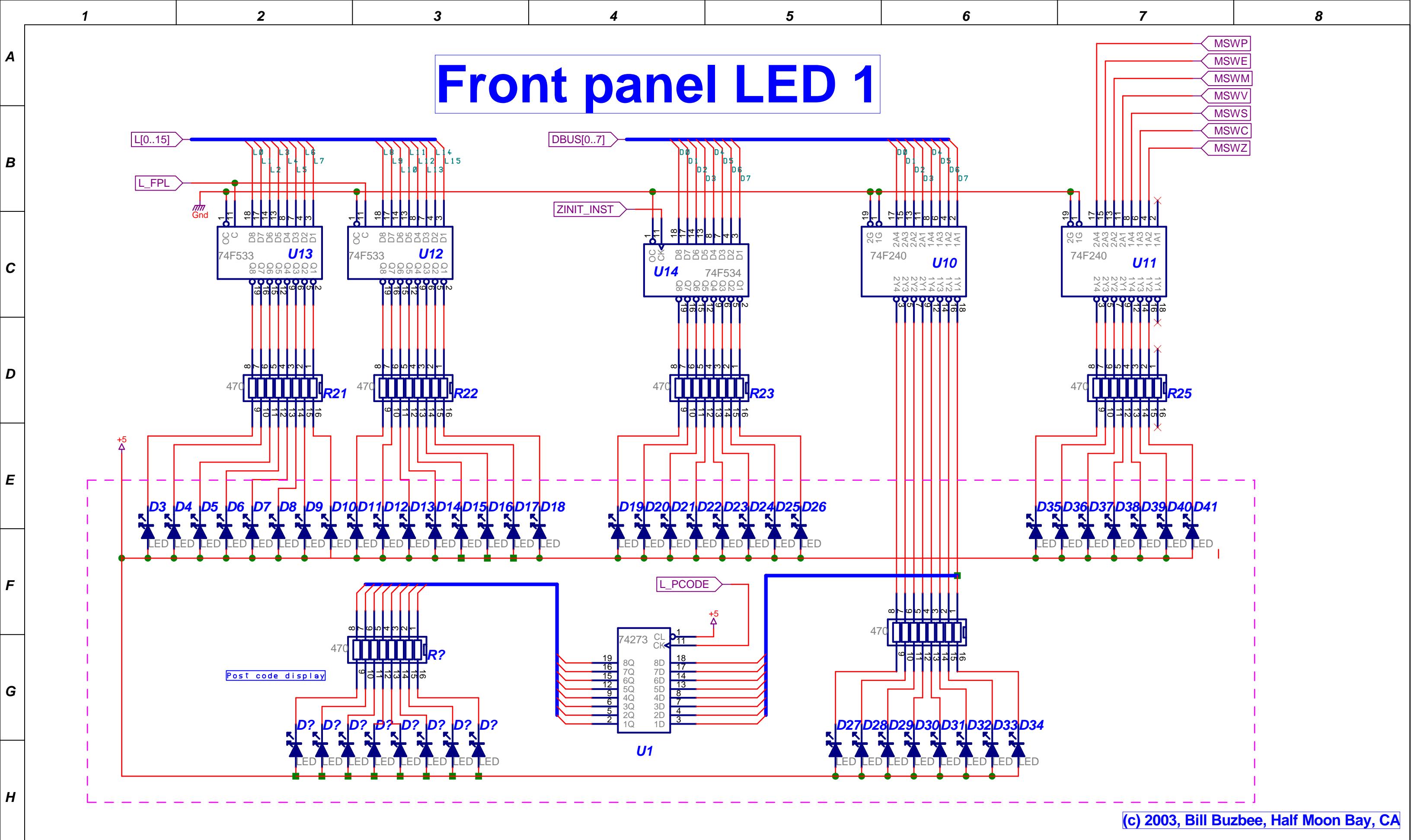
CONN DB09
3v Lithium
MEMORY/DEVICE

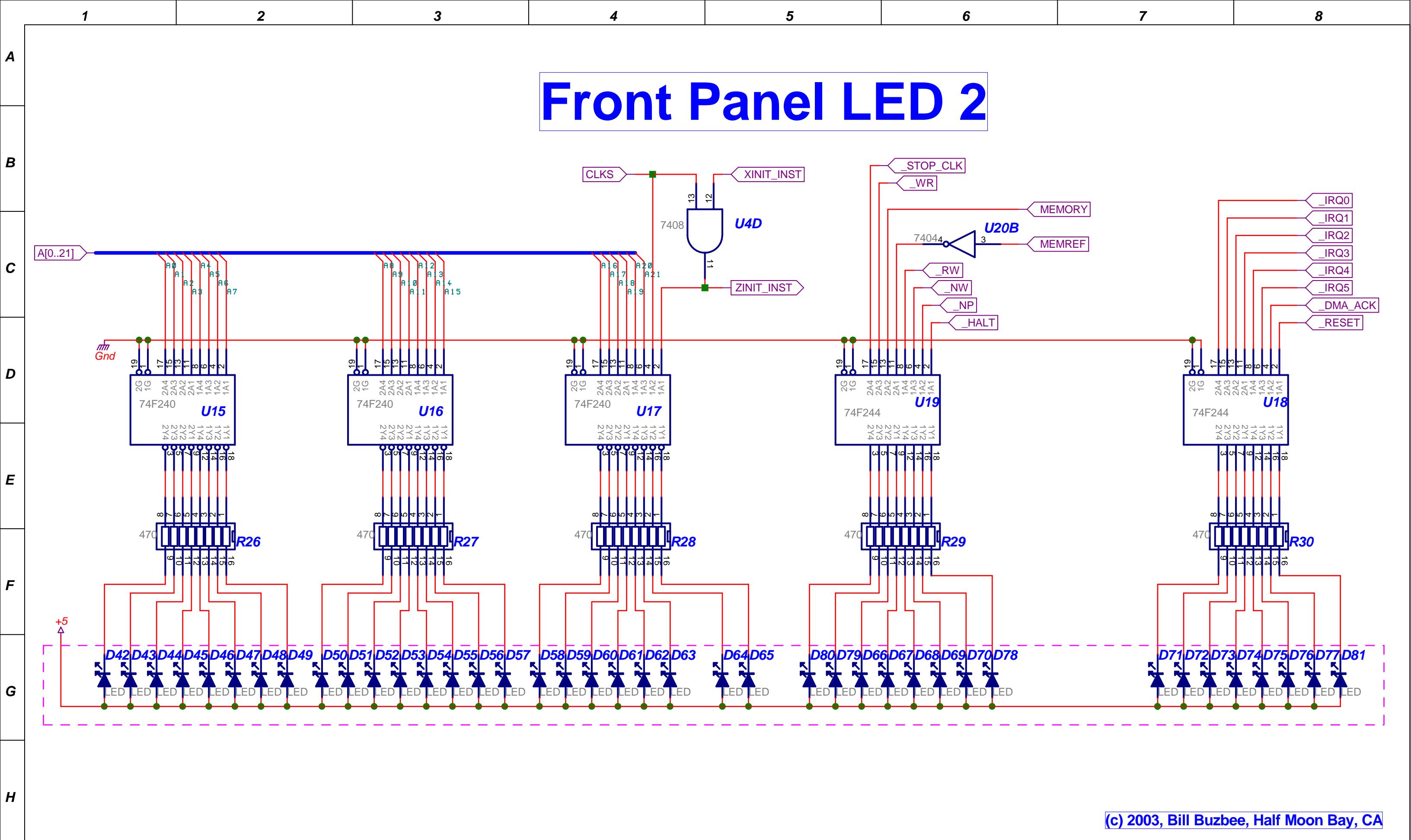
Front Panel Card



cc1 -> component carrier for _FP_WRITE
cc2 -> component carrier for _RESET
cc3 -> component carrier for 555 circuit

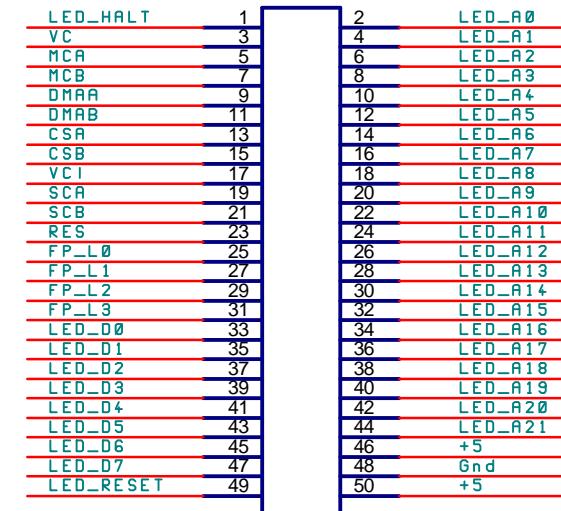




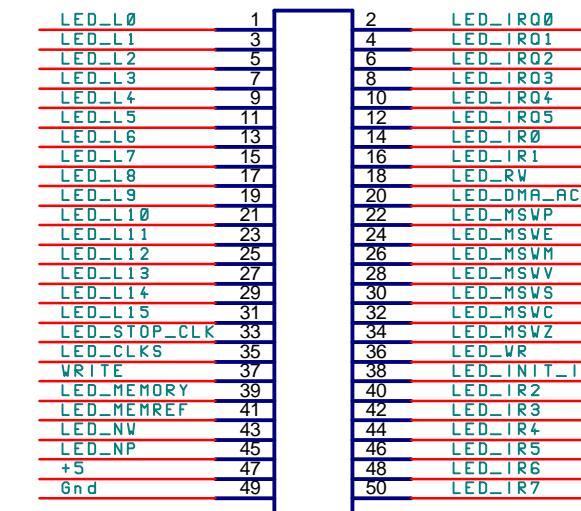


A**B****C****D****E****F****G****H**

Front Panel Ribbon Cable

Right**W1**

Ribbon50

Left**W2**

Ribbon50

Front Panel BOM

Item	Qty	References	Value
1	2	C2,C3	C
2	1	R6	1K
3	1	R20	80
4	1	C1	.01
5	10	R21,R22,R23,R24,R25,R26,R27,R28,R29,R30	470
6	78	D3,D4,D5,D6,D7,D8,D9,D10,D11,D12,D13,D14,D15, D16,D17,D18,D19,D20,D21,D22,D23,D24,D25,D26, D27,D28,D29,D30,D31,D32,D33,D34,D35,D36,D37, D38,D39,D40,D41,D42,D43,D44,D45,D46,D47,D48, D49,D50,D51,D52,D53,D54,D55,D56,D57,D58,D59, D60,D61,D62,D63,D64,D65,D66,D67,D68,D69,D70, D71,D72,D73,D74,D75,D76,D77,D78,D79,D80	LED
7	17	R2,R3,R4,R5,R7,R8,R9,R10,R11,R12,R13,R14,R15, R16,R17,R18,R19	4.7K
8	2	U6,U9	7400
9	1	U20	7404
10	1	U4	7408
11	1	U7	7414
12	1	U3	7474
13	1	U8	7476
14	2	D1,D2	1N914
15	1	U2	74151
16	1	U1	NE555
17	1	R1	R_POT
18	1	S2	RESET
19	1	S5	WRITE
20	5	U10,U11,U15,U16,U17	74F240
21	3	U5,U18,U19	74F244
22	2	U12,U13	74F533
23	1	U14	74F534
24	1	J4	L_SELECT
25	2	W1,W2	Ribbon50
26	1	J1	TurboClk
27	1	J2	NormalClk
28	1	S1	Manual_Clk
29	1	S3	Stop_Clock
30	1	S4	DMA_REQUEST
31	1	J3	CLOCK_SELECT