

TANDY®

Service Manual

25-1000

Supplement to the Tandy® 1000 Service Manual

(Cat. No. 25-1000)

Supplement to the Tandy® 1000 Service Manual

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1/ Introduction

The Tandy 1000A logic board was primarily implemented as a cost reduction of the original design. The only changes to the user features were the addition of a socket to support the 8087 numeric co-processor, the addition of a service adjustable sound volume control, and the addition of a software control bit to disable the internal speaker. However, the visual appearance of the board is considerably different. The original 4 layer circuit board has now been replaced with a 2 layer board, and the IC count has been reduced to 73 IC's.

These changes to the main logic board were accomplished by the addition of three new custom circuits. For your convenience in understanding the operation of both versions of the circuit board, a copy of the original schematic, schematic 8000226, is included, indicating the logic replaced by each of the new custom circuits. Also, a description of the operation of each new custom circuit follows.

2/ Custom Circuits

Custom Address Array

The Custom Address Array (Part No. 8079010) is a 68 PLCC that replaces all of the video address generation logic on sheet 3 of the schematic 8000226. Also, this device incorporates the address decode logic from sheet 5 and sheet 6 of schematic 8000226, and all of sheet 7, except for the 74LS245 data buffer and one 74LS32 OR gate. A pin-out description of the device is given in Figure 1.

Functionally this device is identical to the logic replaced on the original design and the description of the operation of this logic will not be repeated. One new feature has been added to the Custom Address Array circuitry; however, this feature is not used on the present main logic board design. An extra memory address line (MA8) was added to allow the use of 256K x 1 RAM chips. Also, a new control port was added at I/O address 3DD, to control the operation with 256K x 1 RAM chips. The bit definition of this new control port is listed below.

CONTROL PORT 3DD

Bit 0	Reserved
Bit 1	Reserved
Bit 2	Reserved
Bit 3	Video address 17
Bit 4	Video address 18
Bit 5	CPU address 17
Bit 6	CPU address 18
Bit 7	Select 256K RAMs; 0=64K RAMs

This control port is cleared during a reset, and should not be changed.

	9	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	6	6	6	6	6	6	6	
10																		60							
11																		59							
12																		58							
13																		57							
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21																		49							
22																		48							
23																		47							
24																		46							
25																		45							
26																		44							
	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4					
	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3								

Figure 1.1 Pin List

TANDY COMPUTER PRODUCTS

PIN#	PIN NAME	TYPE	DESCRIPTION
1	VDD	POWER	+5 VOLTS
2	IOD1	INPUT/OUTPUT	DATA BUS BIT 1
3	IOD0	INPUT/OUTPUT	DATA BUS BIT 0
4	HSYNC	OUTPUT	6845 HORIZONTAL SYNC
5	VSYNC	OUTPUT	6845 VERTICAL SYNC
6	A*	OUTPUT	ENCODED PERIPHERAL ADDRESS SELECT (LSB)
7	B*	OUTPUT	ENCODED PERIPHERAL ADDRESS SELECT
8	C*	OUTPUT	ENCODED PERIPHERAL ADDRESS SELECT (MSB)
9	IOSEL*	OUTPUT	I/O SELECT
10	LPSW*	INPUT	LIGHT PEN SET (ACTIVE LOW)
11	RA0	OUTPUT	6845 ROW ADDRESS 0
12	RA1	OUTPUT	6845 ROW ADDRESS 1
13	RA2	OUTPUT	6845 ADDRESS 2
14	RA3	OUTPUT	6845 ADDRESS 3
15	GACS*	OUTPUT	
16	MEMSEL*	OUTPUT	
17	VS*	OUTPUT	
18	ROMCS*	OUTPUT	ROM CHIP SELECT
19	IO/M	INPUT	I/O /MEMORY
20	BMEMW*	INPUT	MEMORY WRITE
21	BMEMR*	INPUT	MEMORY READ
22	RFSH*	INPUT	MEMORY REFRESH
23	BA19	INPUT	ADDRESS 19
24	BA18	INPUT	ADDRESS 18
25	BA17	INPUT	ADDRESS 17
26	BA16	INPUT	ADDRESS 16
27	BA15	INPUT	ADDRESS 15
28	BA14	INPUT	ADDRESS 14
29	BA13	INPUT	ADDRESS 13
30	BA12	INPUT	ADDRESS 12
31	BA11	INPUT	ADDRESS 11
32	BA10	INPUT	ADDRESS 10
33	CCLK*	INPUT	6845 CLK
34	VSS	GROUND	GROUND

Figure 1.2 Description of each Pin Function

TANDY COMPUTER PRODUCTS

35	BA09	INPUT	ADDRESS 9
36	BA08	INPUT	ADDRESS 8
37	BA07	INPUT	ADDRESS 7
38	BA06	INPUT	ADDRESS 6
39	BA05	INPUT	ADDRESS 5
40	BA04	INPUT	ADDRESS 4
41	BA03	INPUT	ADDRESS 3
42	BA02	INPUT	ADDRESS 2
43	BA01	INPUT	ADDRESS 1
44	BA00	INPUT	ADDRESS 0
45	LPIN	INPUT	LIGHT PEN IN
46	MA0	OUTPUT	MEMORY ADDRESS 0
47	MA1	OUTPUT	MEMORY ADDRESS 1
48	MA2	OUTPUT	MEMORY ADDRESS 2
49	MA3	OUTPUT	MEMORY ADDRESS 3
50	MA4	OUTPUT	MEMORY ADDRESS 4
51	MA5	OUTPUT	MEMORY ADDRESS 5
52	MA6	OUTPUT	MEMORY ADDRESS 6
53	MA7	OUTPUT	MEMORY ADDRESS 7
54	MA8	OUTPUT	MEMORY ADDRESS 8
55	CPU*/CRT	INPUT	CPU /CRT SELECT FOR MA0-8
56	RAS*	INPUT	UPPER /LOWER ADDRESS SELECT FOR MA0-8
57	CURSOR	OUTPUT	6845 CURSOR
58	DISPEN	OUTPUT	6845 DISPEN
59	NMIEN	OUTPUT	NON-MASKABLE INTERRUPT ENABLE
60	SYSRST*	INPUT	SYSTEM RESET
61	BIOW*	INPUT	I/O WRITE
62	BIOR*	INPUT	I/O READ
63	IOD7	INPUT/OUTPUT	DATA BUS BIT 7
64	IOD6	INPUT/OUTPUT	DATA BUS BIT 6
65	IOD5	INPUT/OUTPUT	DATA BUS BIT 5
66	IOD4	INPUT/OUTPUT	DATA BUS BIT 4
67	IOD3	INPUT/OUTPUT	DATA BUS BIT 3
68	IOD2	INPUT/OUTPUT	DATA BUS BIT 2

FIGURE 1.2 (con't)

Custom Timing Generator Array

The Custom Timing Generator Array (Part No. 8079011) functionally replaces the circuitry found on schematic 8000226, sheet 1 (bottom) and sheet 2. Referring to the enclosed block diagram of the Custom Timing Generator (Figure 2), the top block is MEMORY TIMING, GENERATOR, which is described in the Tandy 1000 service manual under "OSCILLATOR TIMING, AND DYNAMIC RAM CONTROL" page 20. The timing is unchanged.

The second, third, and fourth block represent the 8284. This is described in the service manual under CPU CONTROL SIGNAL GEN. CPUOSC input is connected to CLK14M. RD41N replaces RD41, RD42, AEN1, and AEN2. The 10WAIT signal is generated internally.

The fifth block represents the CONTROL SIGNAL GENERATION which is described in the service manual page 26 under "SYSTEM CONTROL SIGNAL GENERATION." The difference here is that with the Custom Timing Generator, the 8088 is operating in the "MAX MODE." Thus the status signal "SSO, IO/M, DT/R are replaced by S0B, S1B, S2B which tri-state during T4 instead of changing at ALE. This requires a revision to timing diagram (page 27 of the service manual as provided in Figure 4).

The final block is the ARBITER which interfaces the 8088 in "MAX MODE" with the current "HOLD, HLDA" signals on the bus. Since this circuit is new, a description follows.

In the "MAX MODE" the 8088 uses two REQUEST/GANT signals, RT/GT0 and RT/GT1, which are bi-directional. The operational sequence of the ARBITER is as follows: When the HOLD input goes true, a negative-going request pulse is sent to the 8088 via the RT/GT pin (used as an output at this time). RT/GT now functions as an input to the Custom Timing Generator, which is waiting for a negative-going "GRANT" signal from the 8088. When the GRANT is received the bus signal HLDA is set. When the bus signal HOLD goes false, the RT/GT line again functions as an output, sending the third RT/GT pulse, "RELEASE", to the 8088. (See 8088 specifications for details). Enclosed is an additional timing diagram for ARBITER.

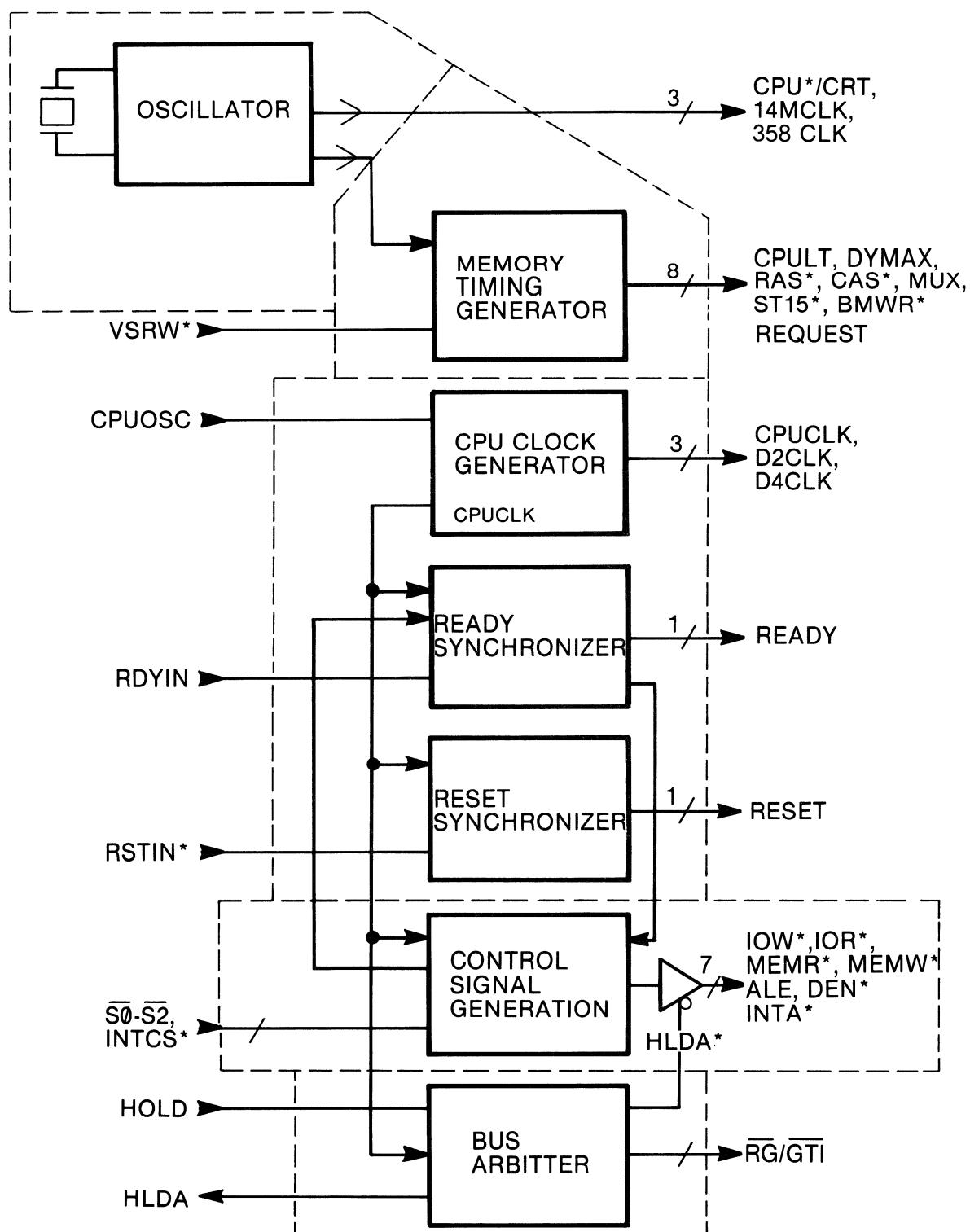
TANDY COMPUTER PRODUCTS

Figure 2 Custom Timing Generator Array Block Diagram

1		40
2		39
3		38
4		37
5		36
6		35
7		34
8	Custom Timing Generator	33
9		32
10		31
11	40 PIN PDIP	30
12		29
13		28
14		27
15		26
16		25
17		24
18		23
19		22
20		21

Figure 3.1 Pin List

TANDY COMPUTER PRODUCTS

PIN#	PIN NAME	TYPE	DESCRIPTION
1	D2CLK	OUTPUT	CPUCLK DEVIDE BY 2
2	D4CLK	OUTPUT	CPUCLK DEVIDE BY 4
3	RESET	OUTPUT	SYNC. RESET OUT
4	IOB/M	OUTPUT	MEMORY NOT I/O
5	READY	OUTPUT	SYNC. SYSTEM READY
6	ALE	OUTPUT	ADDRESS LATCH ENABLE
7	INTCSB	INPUT	INTERRUPT CHIP SELECT
8	DENB	OUTPUT	CPU DATA ENABLE
9	MEMRB	OUTPUT	CPU MEMORY READ
10	INTAB	OUTPUT	CPU INTERRUPT ACKNOWLEDGE
11	MEMWB	OUTPUT	CPU MEMORY WRITE
12	IOWB	OUTPUT	CPU I/O WRITE
13	IORB	OUTPUT	CPU I/O READ
14	READ	OUTPUT	CPU READ
15	RDYIN	INPUT	ASYNC. READY
16	S0B	INPUT	CPU STATUS 0
17	S1B	INPUT	CPU STATUS 1
18	S2B	INPUT	CPU STATUS 2
19	CPUOSC	INPUT	CPU OSC INPUT
20	VSS	GROUND	GROUND
21	RSTINB	INPUT	ASYNC. RESET INPUT
22	XTALIN	INPUT	28 MHZ CRYSTAL INPUT
23	XTALOUT	OUTPUT	28 MHZ CRYSTAL OUTPUT
24	VSACCB	INPUT	MEMORY ADDRESS DECODE
25	CLK14M	OUTPUT	14 MHZ CLOCK
26	CPUCLK	OUTPUT	SYSTEM CPU CLOCK
27	CLK358M	OUTPUT	3.58 MHZ CLOCK
28	CPUBCRT	OUTPUT	1.9 MHZ - CPU VIDEO RAM ACCESS MUX
29	ST15B	OUTPUT	VIDEO SYNC. STROBE
30	RASB	OUTPUT	RAM ROW ADDRESS STROBE
31	DYMUX	OUTPUT	VIDEO DATA LATCH STROBE
32	VSWRB	INPUT	SYSTEM MEMORY WRITE
33	BMW RB	OUTPUT	SYSTEM RAM WRITE STROBE
34	CPULT	OUTPUT	CPU DATA LATCH
35	REQUEST	OUTPUT	REQUEST
36	CASB	OUTPUT	RAM COLUMN ADDRESS STROBE
37	RQ/GTB	BI-DIR	REQUEST GRANT
38	HLDA	OUTPUT	CPU HOLD ACK.
39	HOLD	INPUT	CPU POWER
40	VDD	POWER	POWER

Figure 3.2 Description Of Each Pin Function

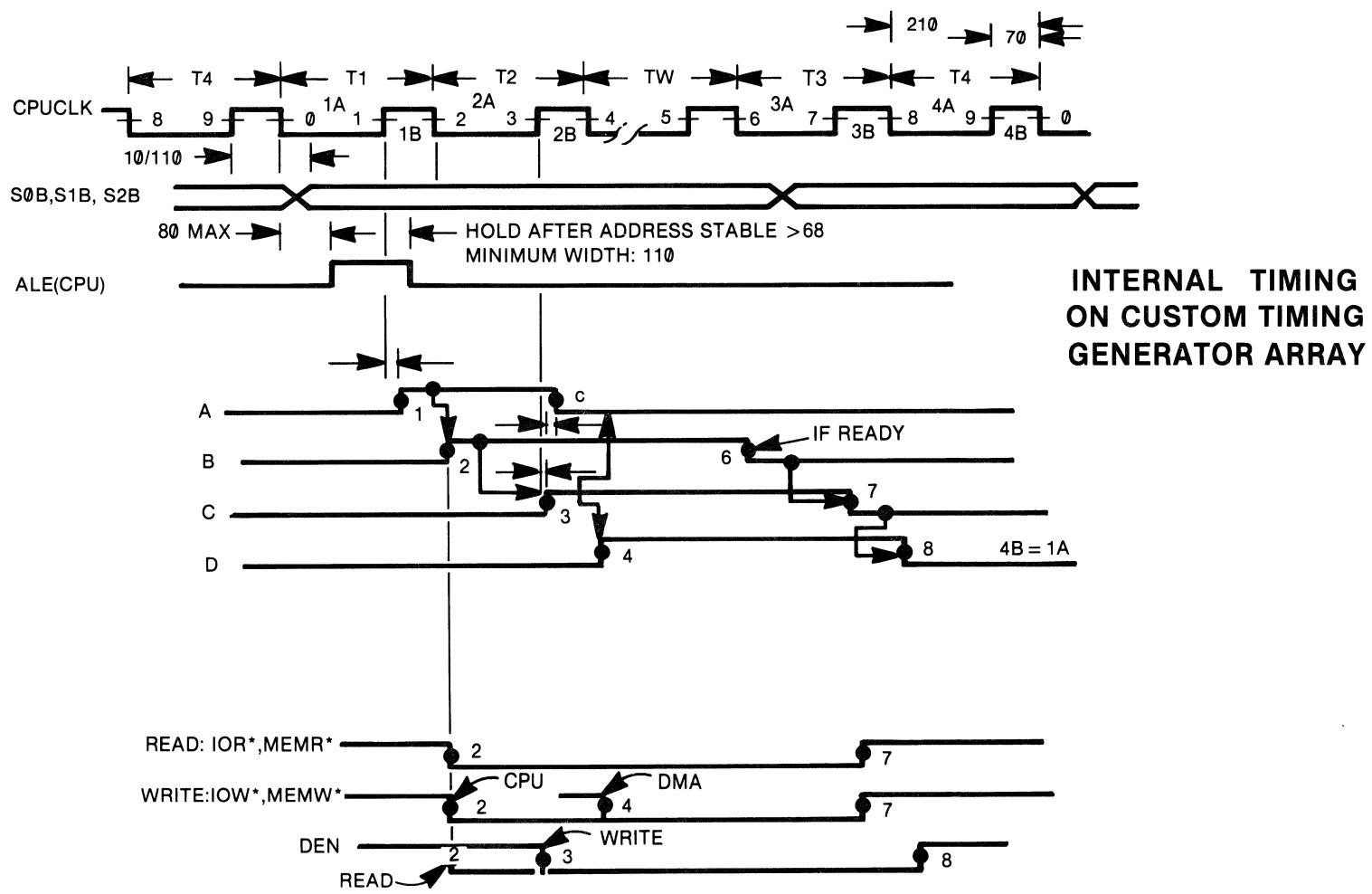
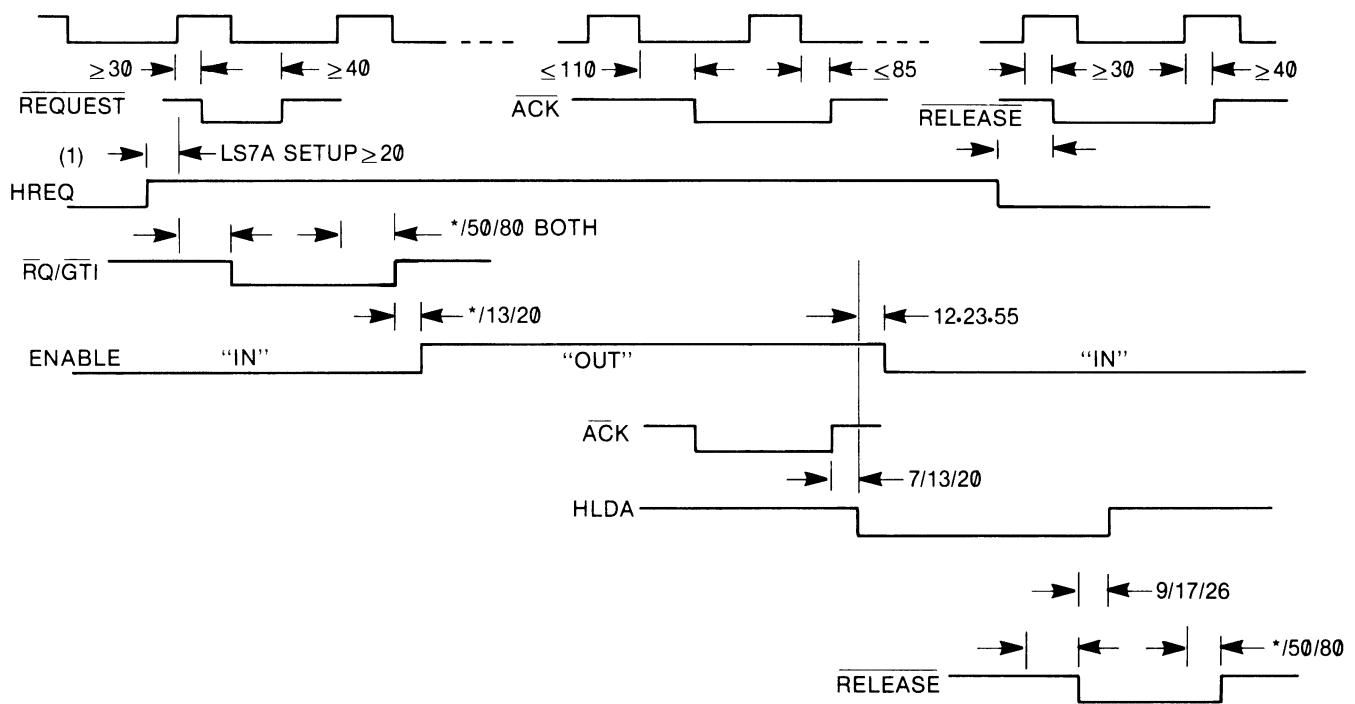
TANDY COMPUTER PRODUCTS

Figure 4 Timing Diagram

(All Times in Nanoseconds)



DMA 9517:
 (1) HREQ GENERATED BY CLK
 CLK = CPU CLK

Figure 5 Bus Arbitter Timing

Custom Keyboard I/F Array

The Custom Keyboard I/F Array (Part No. 8079012) replaces the 8255 and keyboard control logic from sheet 8 of schematic 8000226. This logic is functionally identical to the original design with the exception that the 8255 logic is no longer programmable. Since the original design requires the correct programming of the 8255, this change in no way affects the usefulness of the circuit.

One change associated with the Custom Keyboard Array is the addition of a software control bit to disable the internal speaker. This control bit is I/O location 0061 bit 4. A "1" at this location disables the internal speaker. A pin-out for the Custom Keyboard Array is given in Figure 6.

1	KBCLK	UDD	40
2	KBDATA	MULCLK	39
3	KBBUSY	MULDATA	38
4	KBINT	PC3	37
5	KBIZ0	TCH2G	36
6	KBIZ1	PPITIM	35
7	IOD0	DS0	34
8	IOD1	DS1	33
9	IOD2	FDCRST	32
10	IOD3	DMA/I	31
11	IOD4	MTRON	30
12	IOD5	FDCTC	29
13	IOD6	SNDCLW	28
14	IOD7	SNDCL0	27
15	PIOCS	SNDCL1	26
16	BA00	TMROUT2	25
17	BA01	PC4	24
18	BIOR	SYSRST	23
19	BIOW	KBRST	22
20	VSS	DORCLK	21

Figure 6 Custom Keyboard Array

TANDY COMPUTER PRODUCTS

3/ Parts List**Tandy 1000A Main Logic**

Quantity	Description	RS Part No.
----------	-------------	-------------

Main Logic Main Assembly

1	Chassis, Main	8729314
1	Support, Disk Drives	8729313
3	Panel, Option Board	8729312
1	Power Supply 54W	8790070
1	Enclosure Power Supply	8729321
1	Panel Rear (Monsanto 337 Used on Domestic only)	8719494
1	Case Top	8719495
1	Shielrt, RFI	8729543
4	Clip, RFI Shield	8729238
7	B Mounts	8565017
1	Button Reset, Front	8719440
1	Button Reset, Rear	8719441
1	Disk Drive, 5 1/4"	8790127
1	Cable Signal Floppy Disk	8709563
1	Cable, AC In	8709584
1	Harness, AC	8709553
1	Fan	8790401
1	Speaker	8490009
1	Cable, Speaker	8709574
1	Label, Caution (Option Bds.)	87891375
2	Faston Ground Connector	8529018
2	Screw 4-40 x 3/8"	8569002
2	Nut, Keps 4-40	8579003
1	Main Logic T1000 PCB Sub Assy.	8857139

TANDY COMPUTER PRODUCTS

Symbol	Description	RS Part No.
Main Logic Sub Assembly		
	Main Logic T1000 PC Board Rev. B	8709604B
C1-4,7-9,24, 26-38,41, 44-48,49A, 50-60,63-71, 74-78,81-89, 113-115,119	Capacitor 0.1 MFD 50V 80% Axial	8374104
C5,49,72,79, 80,110,110A	Capacitor 22 MFD 16V +20 Axial	8316221
C6,112	Capacitor 100 MFD 16V NP AX.	8317101
C10,25,106, 109,111	Capacitor 10 MFD 16V Elec Axial	8316101
C10A	Capacitor 100 PFD 50V 10%	8301104
C11,12,55A	Capacitor 0.1 MFD Radial monolithic	8384104
C13-16,13A-16A	Capacitor 68 PFD 50V 10%	8300584
C17-22,86A, 90-92,101, 101A,105B	Capacitor 20PF 50V +80-20	8300204
C23	Capacitor 0.01 MFD 50V 20%	8303104
C39	Capacitor 0.022 MFD 63V 10% Poly	8393225
C42	Capacitor 220 PFD 50V 10%	8301223
C43,102-105, 102A,105A, 112A	Capacitor 470 PFD 50V 10%	8301474
C73	Capacitor 180 PFD 50V 10%	8301184
C93-100	Capacitor 2200 PFD 50V 10%	8302224
C107	Capacitor 0.47 MFD 50V 80/20%	8384475
C108	Capacitor 330 PFD 50V C. 5%	8301332
CR1	Diode IN5235 6.8V	8150235
CR2	Zener Diode 1N4148 75V	8150148
El-2,3-4,8-9 El-9	Jumper Plugs Staking Pins AMP 1-87	8519098 8529014

TANDY COMPUTER PRODUCTS

Symbol	Description	RS Part No.
FB1	Inductor, Ferrite Bead	8419014
FB2	Ferrite Bead W/Lead	8419013
J1	Connector, 2-Pin Straight Header	8519193
J2, 3	Connector, 6-Pin Rt. Angle	8519095
J4	Connector, 8-Pin Rt. Angle	8519203
J5	Connector, Dual 17-Pin Straight Headr	8519120
J6	Connector, 9-Pin St. Frict. Lock	8519191
J7, 8, 9	Connector, Dual 31-Pin Straight Card Edge	8519236
J11	Connector, 9-Pin Rt. Angle Male "D" Sub (Low cost, Snap in)	8519235
J12	Connector, 9-Pin Rt. Angle Female "D" Sub	8519245
J13	Connector, Dual RCA Phono Jack Rt. Angle	8519213
Q1	Transistor PNP 2N3906	8100906
Q2	Transistor VMOS VN0104N3	8190104
Q3	Transistor NPN 2N3904	8110904
R1	Resistor Variable 1K	8279411
R2	Resistor 6.8K Ohm 1/4 Watt 5%	8207268
R4, 45	Resistor 10 Ohm 1/4 Watt 5%	8207010
R5	Resistor 330 Ohm 1/4 Watt 5%	8207133
R6, 10, 13, 15, 17, 23, 28, 30, 44, 46, 47, 57-59	Resistor 10K Ohm 1/4 Watt 5%	8207310
R7, 18A, 32	Resistor 560 Ohm 1/4 Watt 5%	8207156
R17A, 20, 29, 31, 33	Resistor 4.7K Ohm 1/4 Watt 5%	8207247
R8	Resistor 82.5K Ohm 1/4 Watt 1%	8200382
R9, 12, 14, 16	Resistor 1 Meg Ohm 1/4 Watt 5%	8207510
R11	Resistor 680K Ohm 1/4 Watt 5%	8207468
R18, 19	Resistor 910 Ohm 1/4 Watt 5%	8207191
R21, 26	Resistor 1K Ohm 1/4 Watt 5%	8207210
R22, 27	Resistor 47 Ohm 1/4 Watt 5%	8207047
R24	Resistor 33 Ohm 1/4 Watt 5%	8207033
R35	Resistor 750 Ohm 1/4 Watt 5%	8207175
R34, 52-56	Resistor 2.2K Ohm 1/4 Watt 5%	8207222

TANDY COMPUTER PRODUCTS

Symbol	Description	RS Part No.
R36	Resistor 1.1K Ohm 1/4 Watt 5%	8207211
R37	Resistor 3.3K Ohm 1/4 Watt 5%	8207233
R38, 43	Resistor 680 Ohm 1/4 Watt 5%	8207168
R39	Resistor 1.2K Ohm 1/4 Watt 5%	8207212
R40	Resistor 270 Ohm 1/4 Watt 5%	8207127
R41	Resistor 620 Ohm 1/4 Watt 5%	8207162
R42	Resistor 100 Ohm 1/4 Watt 5%	8207110
R42A	Resistor 2.7K Ohm 1/4 Watt 5%	8207227
R48	Resistor 75 Ohm 1/4 Watt 5%	8207075
R50, 51	Resistor 100K Ohm 1/4 Watt 5%	8207410
	Resistor 10K Ohm (added near R33 to eliminate noise from light pen circuit)	
RP1	Resistor Pak 33 Ohm 6-Pin Sip	8290056
RP2, 6	Resistor Pak 10K Ohm 8-Pin Sip	8292310
RP3, 4, 12	Resistor Pak 33 Ohm 8-Pin Sip	8295033
RP5, 7	Resistor Pak 1K Ohm 8-Pin Sip	8290212
RP9	Resistor Pak 10K Ohm 10-Pin Sip	8290010
RP10	Resistor Pak 4.7K Ohm 8-Pin Sip	8292246
RP11	Resistor Pak 33 Ohm 16-Pin Dip	8290044
S1	Switch, Reset	8489065
U1-4, 10, 11, 18-21, 32-35, 4, 45, 70	Socket 16-Pin Dip	8509003
U1-4, 10, 11, 18-21, 32-35, 44, 45	IC 64K x 1 Dram 150 NS	8043665
U5, 22	IC 74LS374N Flip Flop	8020374
U6, 23, 54*, 55*	IC, 74LS373N Octal Latch	8020373
U7	LM386N-1 Audio Amp	8050386
U8	Socket 24-Pin Dip	8509001
U8	IC 8253-5 Timer	8040253
U9, 25, 28, 29, 43, 50, 66	Socket 40-Pin Dip	8509002
U9	IC Custom Keyboard I/F Array	8079012
U12	IC 74LS138 Decoder	8020138
U13, 24, 30, 47 49	IC 74LS04 Hex Inverter	8020004
U14, 39, 62, 63	IC74LS32 Quad 2-IN OR Gate	8020032

TANDY COMPUTER PRODUCTS

Symbol	Description	RS Part No.
U15	LM339 Quad Comparato	8050339
U16,48,67	IC 74LS08N Quad 2-IN AND	8020008
U17,51	Socket 28-Pin Dip	8509007
U17	IC 8259A Interrupt Controller	8040259
U25	IC Custom Timing Generator Array	8079011
U26,36,37,40, 41,56,69	IC 74LS244 Octal Buffer	8020244
U27	IC 74LS02 2-IN Nor	8020002
U28	IC 8088 CPU	8048088
U31	IC 74LS112 J K Flip Flop	8020112
U38	IC 74LS05 Hex Inverter	8020005
U40,52,53,73	Socket 20-Pin Dip	8509009
U42	IC 74LS161N Counter	8020161
U43	IC 8272 FDC	8040272
U46	IC74LS174 Flip-Flop	8020174
U50	IC Custom Video Array	8079001
U51	IC 128K ROM	8040328
U52,53,73	IC 74LS245 Tranceiver	8020245
U53 (Pin 19 to +5V)	4.7 Ohm 1/4W 5% CF	8207247
U57	Socket 8-Pin Dip	8509011
U57	IC FDC9216 Data Separator	8040216
U58	IC 7417 Hex Buffer	8000017
U59	IC 74LS14 Hex Inverter	8020014
U60	IC 7416 Hex Inverter Buffer	8000016
U61	IC 74LS195A Shift Register	8020195
U64	Socket 68-Pin, PLCC	8509020
U64	IC Custom Address Array	8079013
U65	IC 7407 Hex Inverter	8000007
U66	IC Custom Gate Array, Printer	8041087
U68	IC 74LS86N Quad 2-IN OR	8020086
U70	IC SN76496 Tone Generator	8040496
U71	IC 14529	8030529
U72	LM358	8050358

* HCT is not an approved substitute for these LS parts.

VR1	Regulator 78L05 ACP +5V	8052805
VR2	Regulator 79M05CT	8190005
VR2	Screw 4-40 x 1/4	8569031
VR2	Nut Keps 4-40	8579003

TANDY COMPUTER PRODUCTS

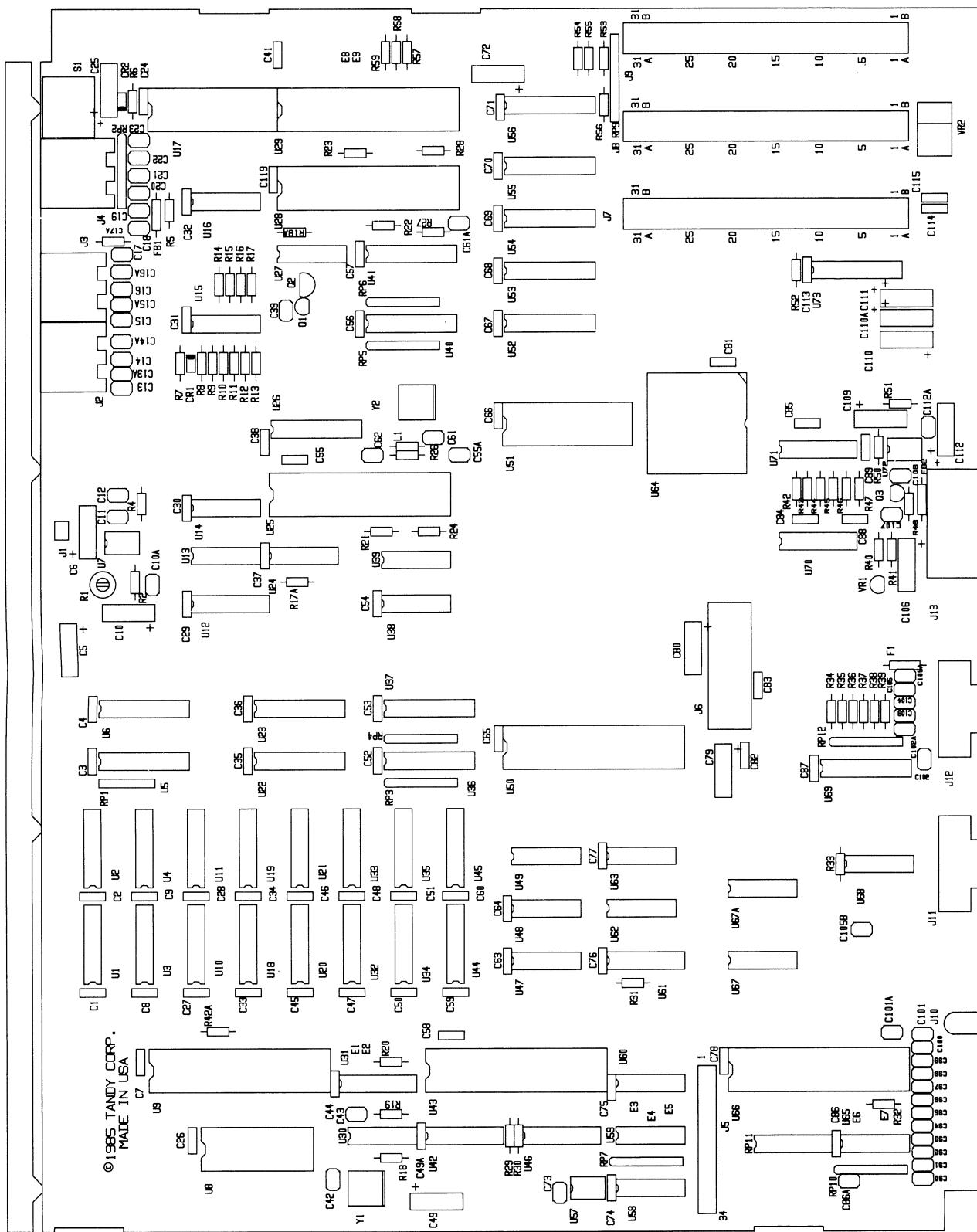
Symbol	Description	RS Part No.
Y1	Crystal 8 MHZ (18PF Loading Capacity)	8409006
Y2	Oscillator 28.63636 MHZ 50 PPM	8409039

Optional Parts

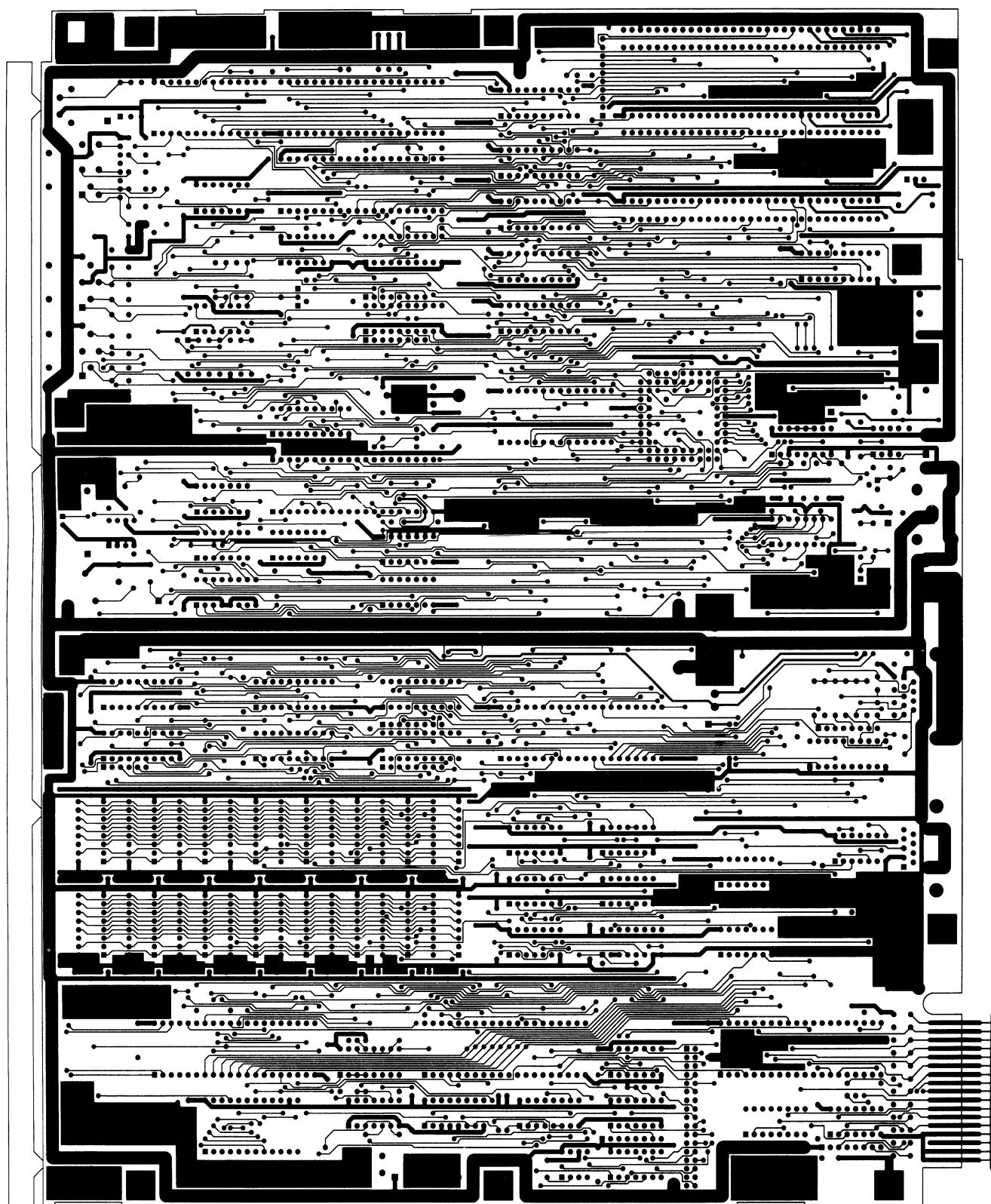
Symbol	Description	RS Part No.
U29	IC 8087	25-1012

Parts Added Or Deleted For International Version

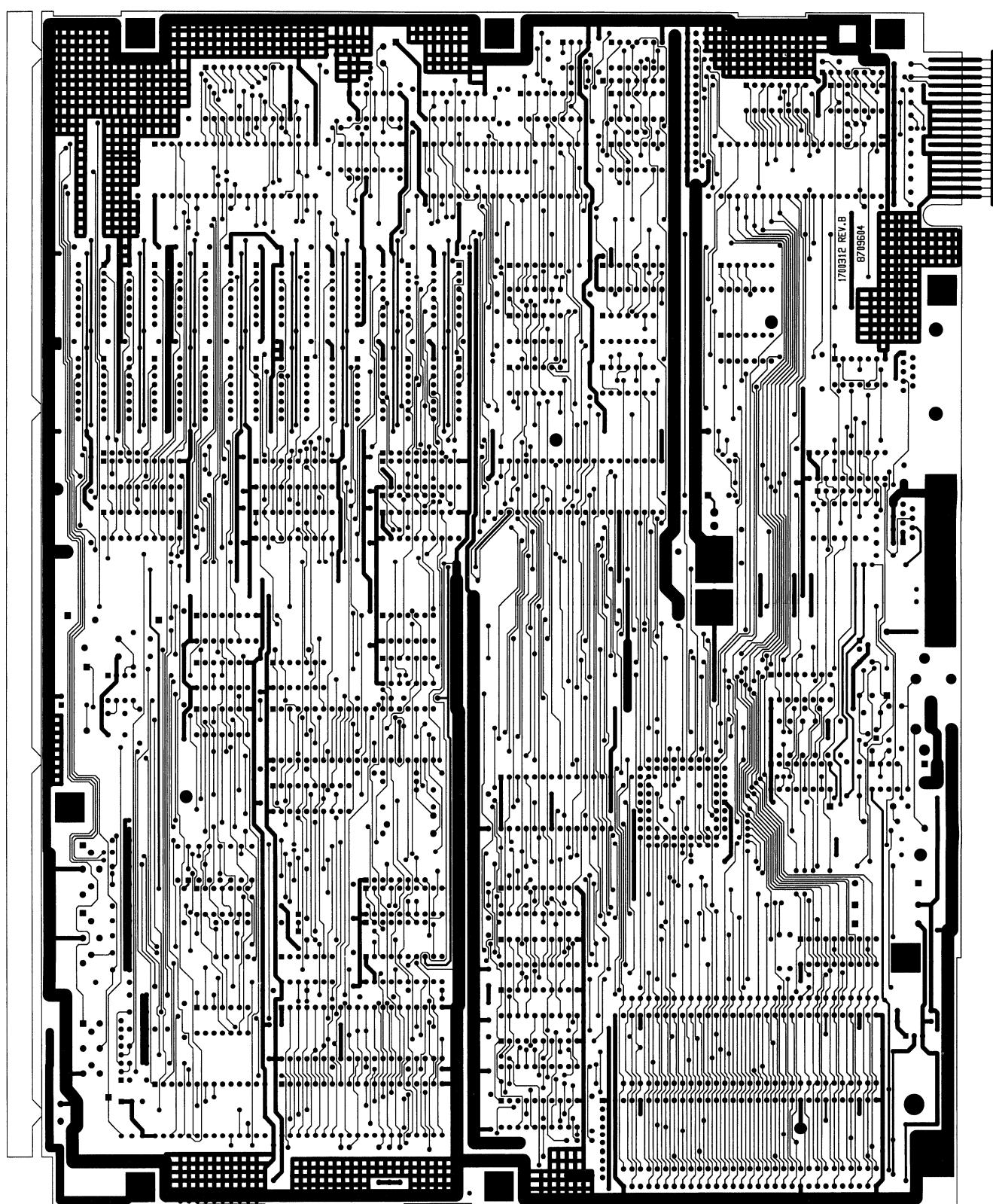
Symbol	Description	RS Part No.
F1	Fuse, 0.25A Pico (ADD)	8479034
Y2	Crystal Oscillator 28.500014 MHZ	8409044

TANDY COMPUTER PRODUCTS**4/ Component Layout**

TANDY COMPUTER PRODUCTS

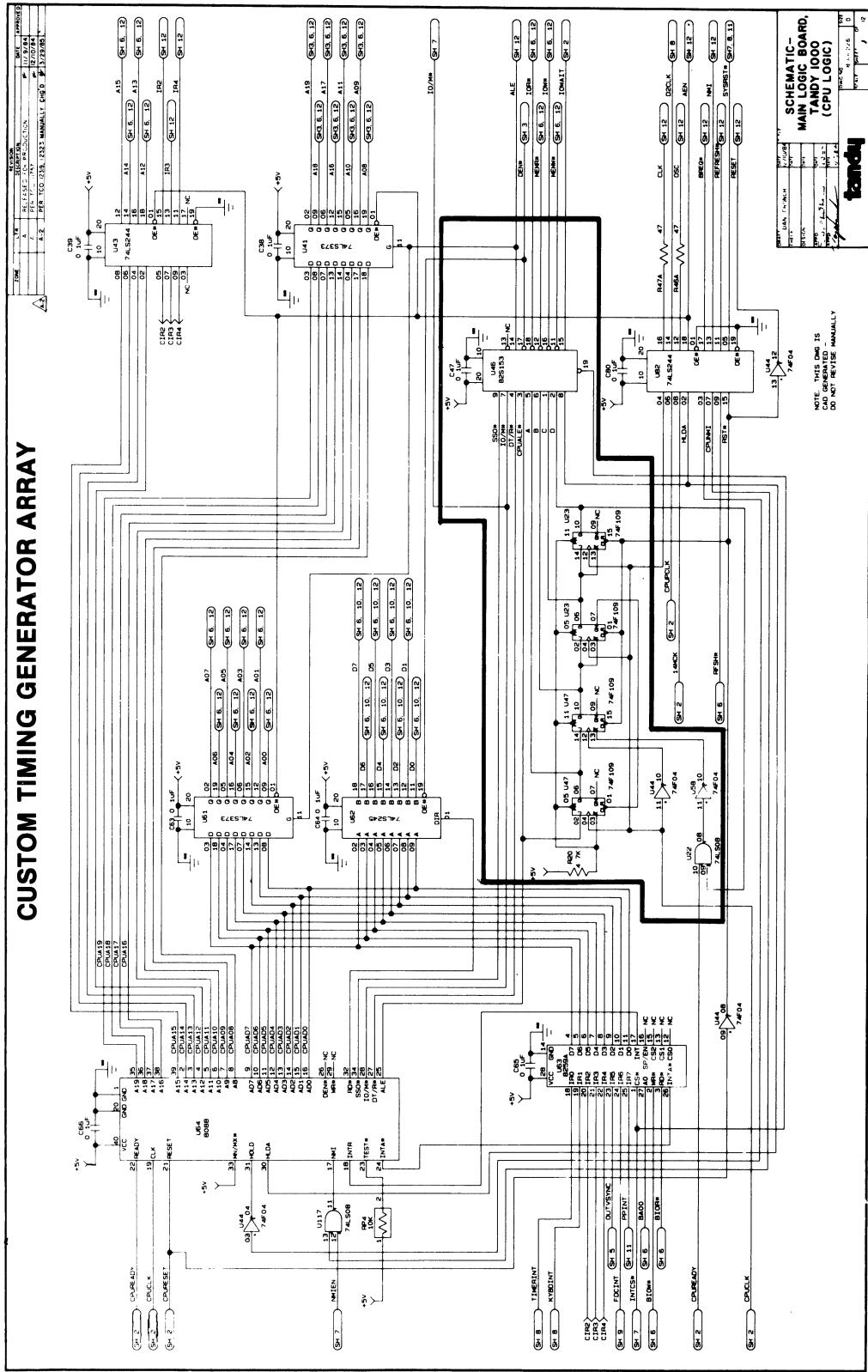


Component Side



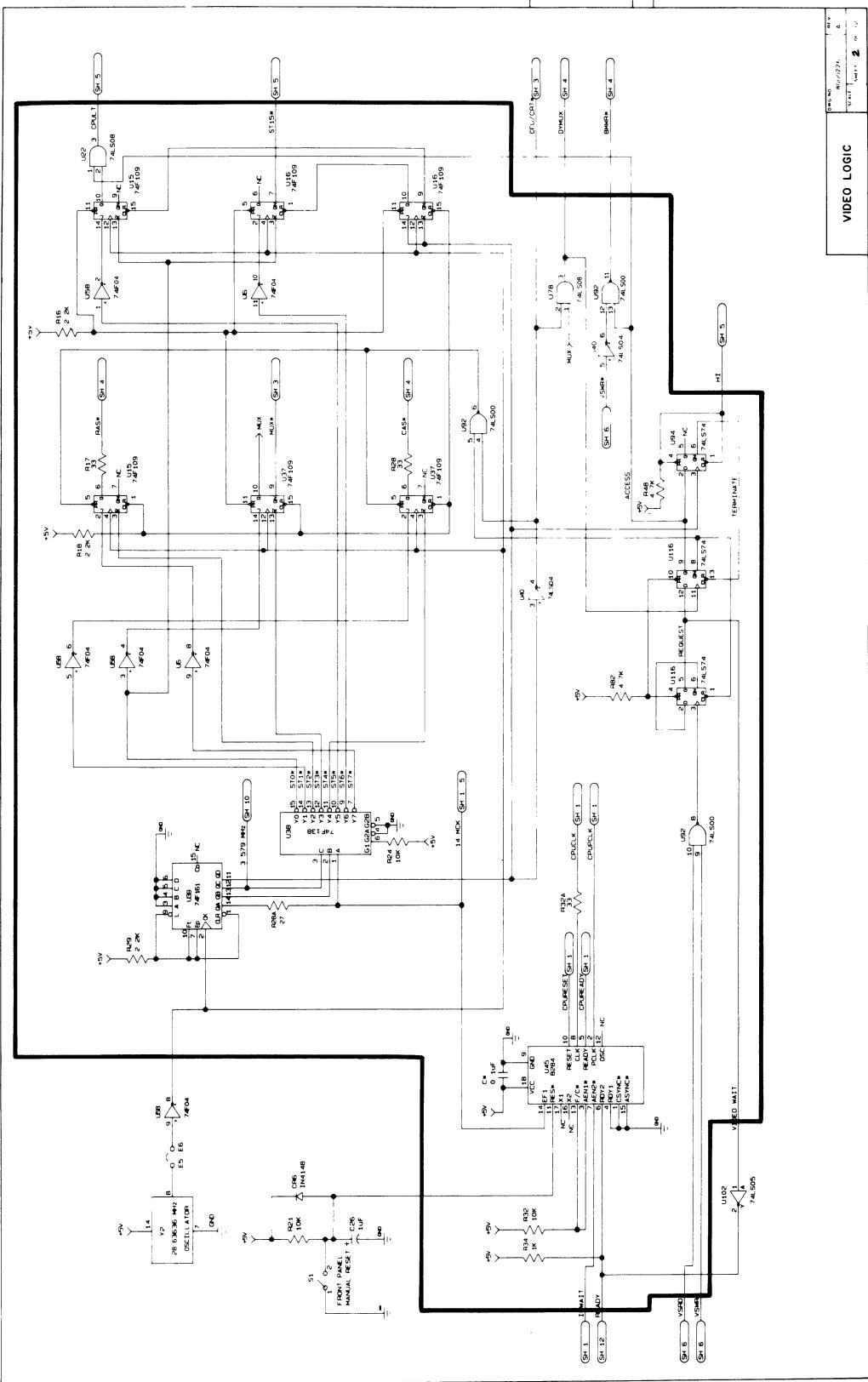
Solder Side

5/ Schematics



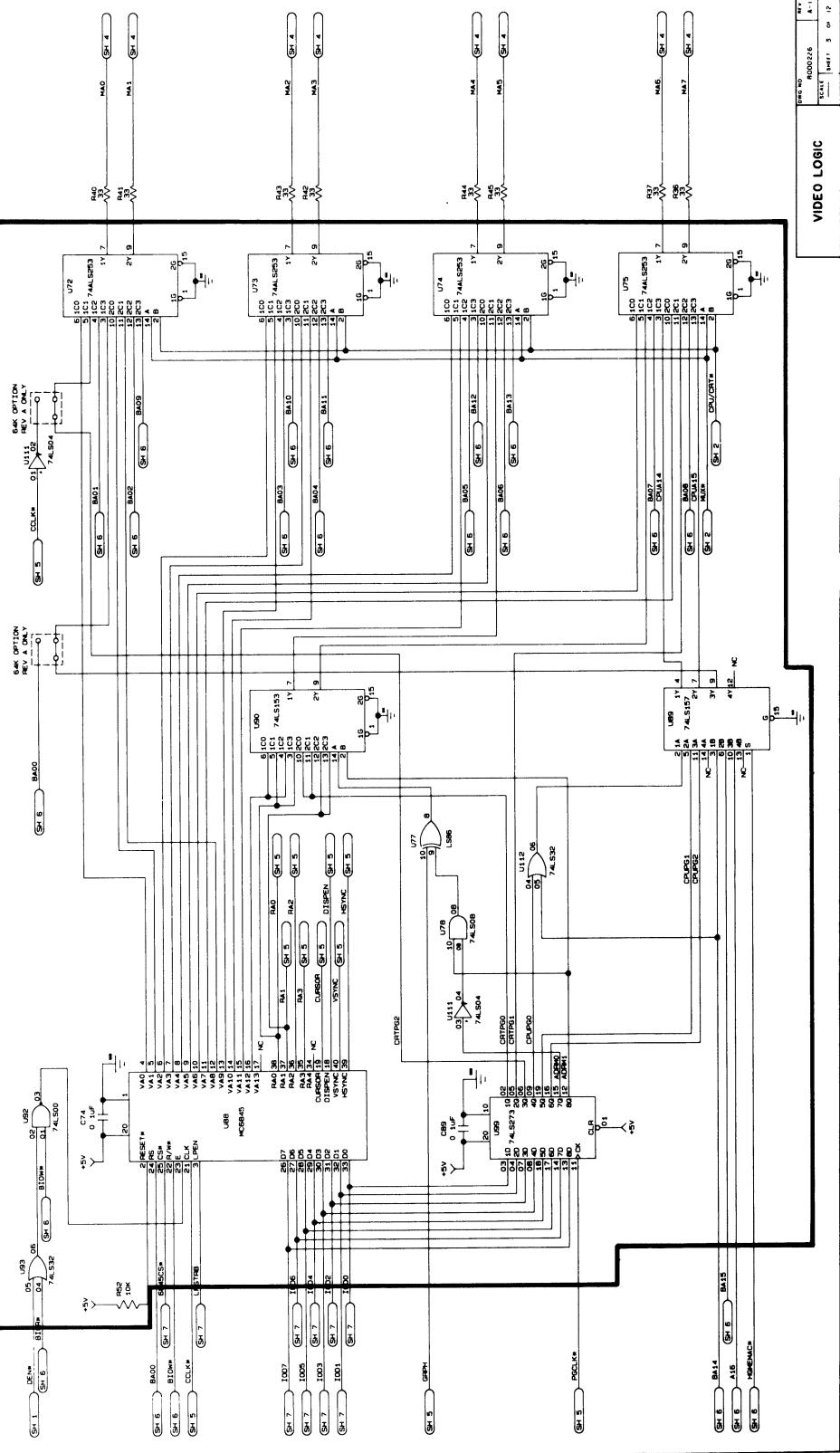
Original Schematics

CUSTOM TIMING GENERATOR ARRAY

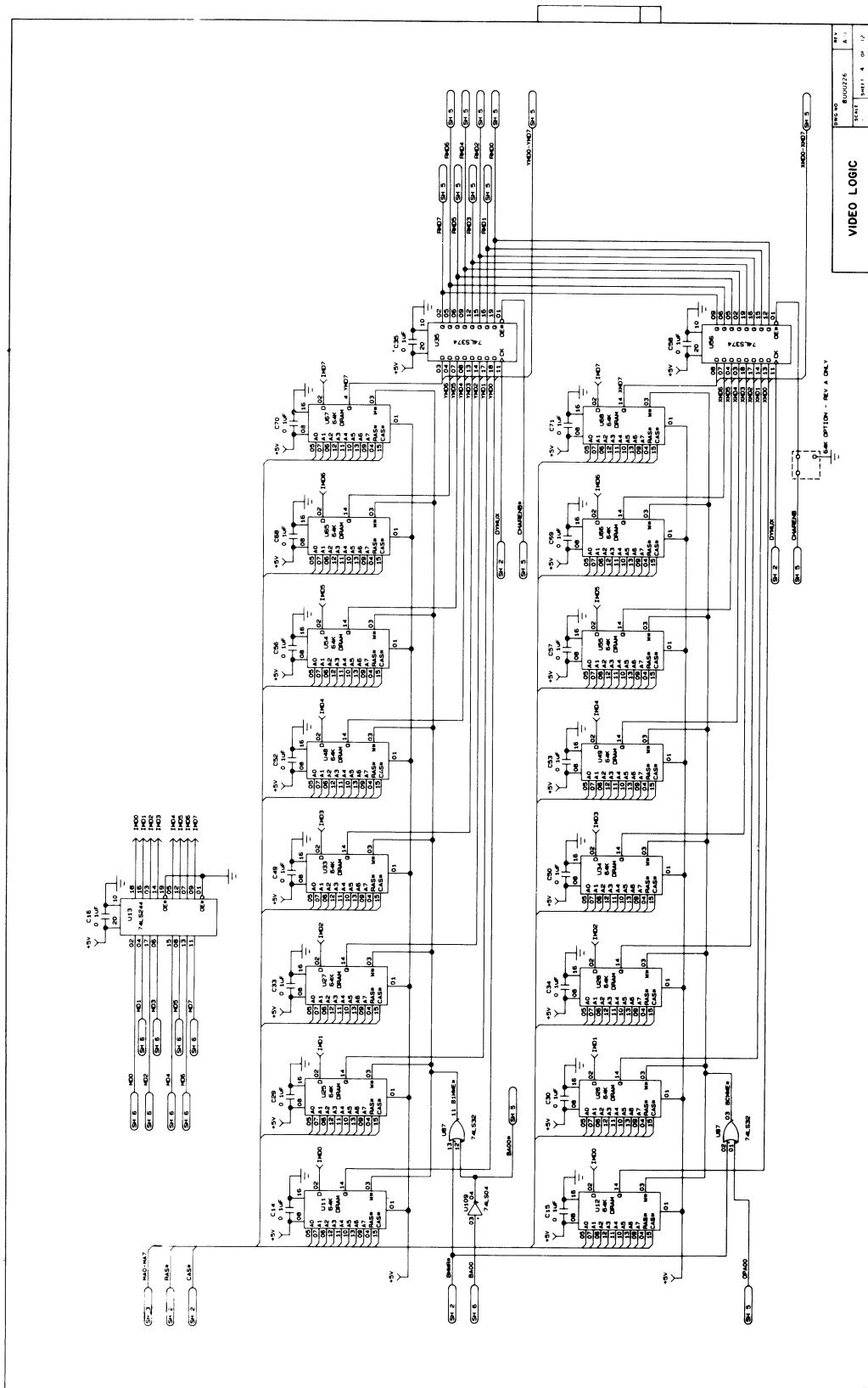


VIDEO LOGIC

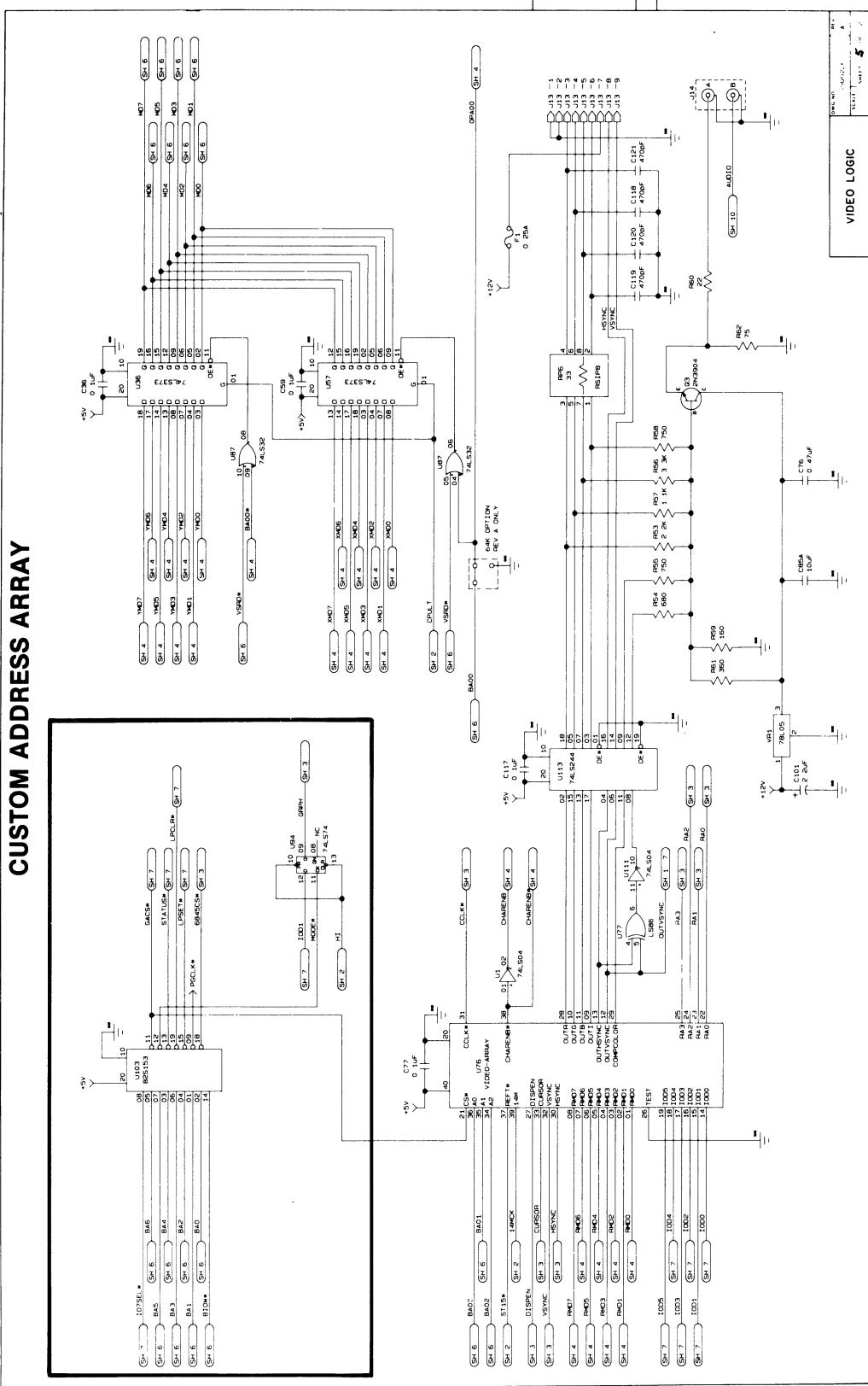
CUSTOM ADDRESS ARRAY



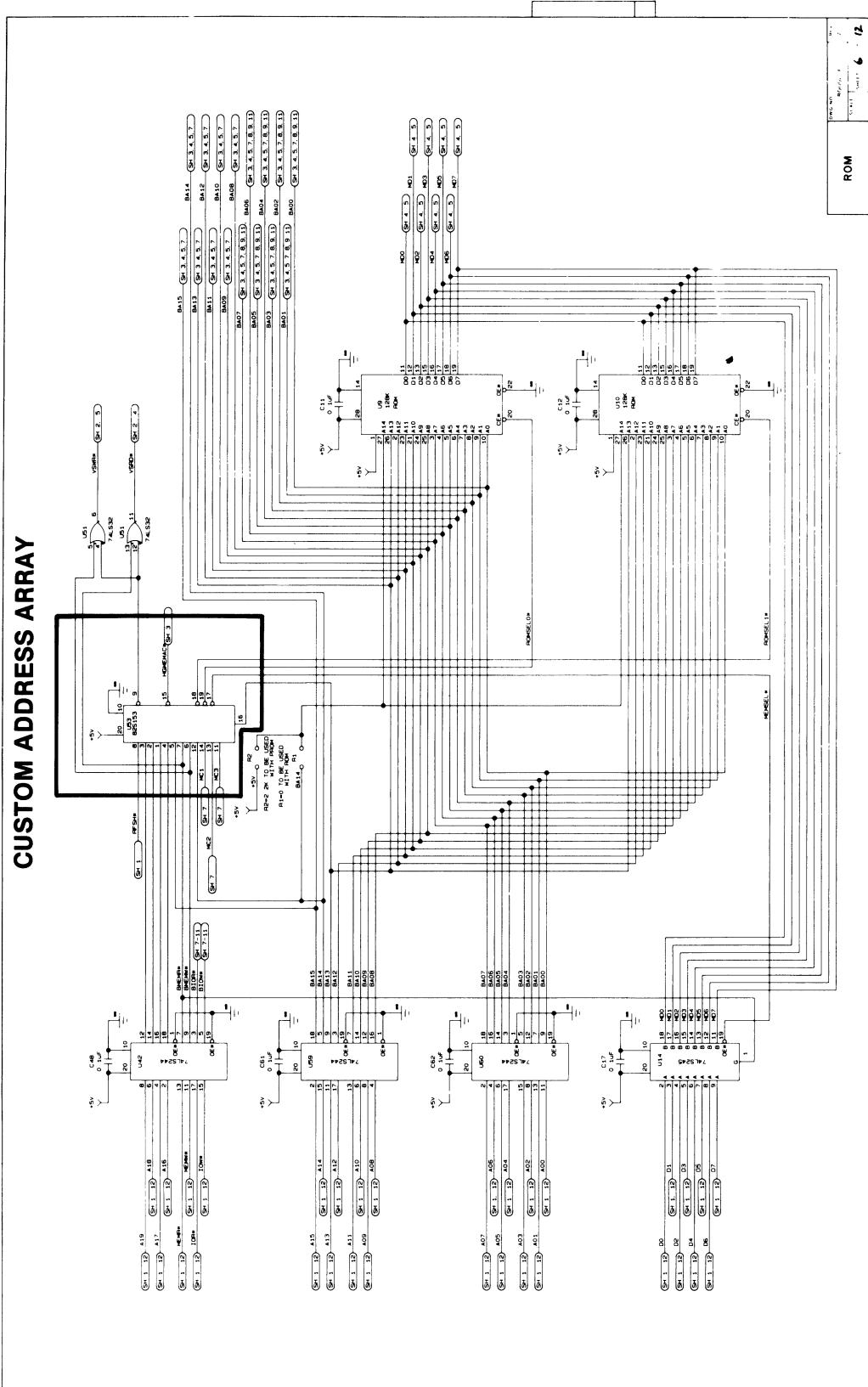
TANDY COMPUTER PRODUCTS



CUSTOM ADDRESS ARRAY

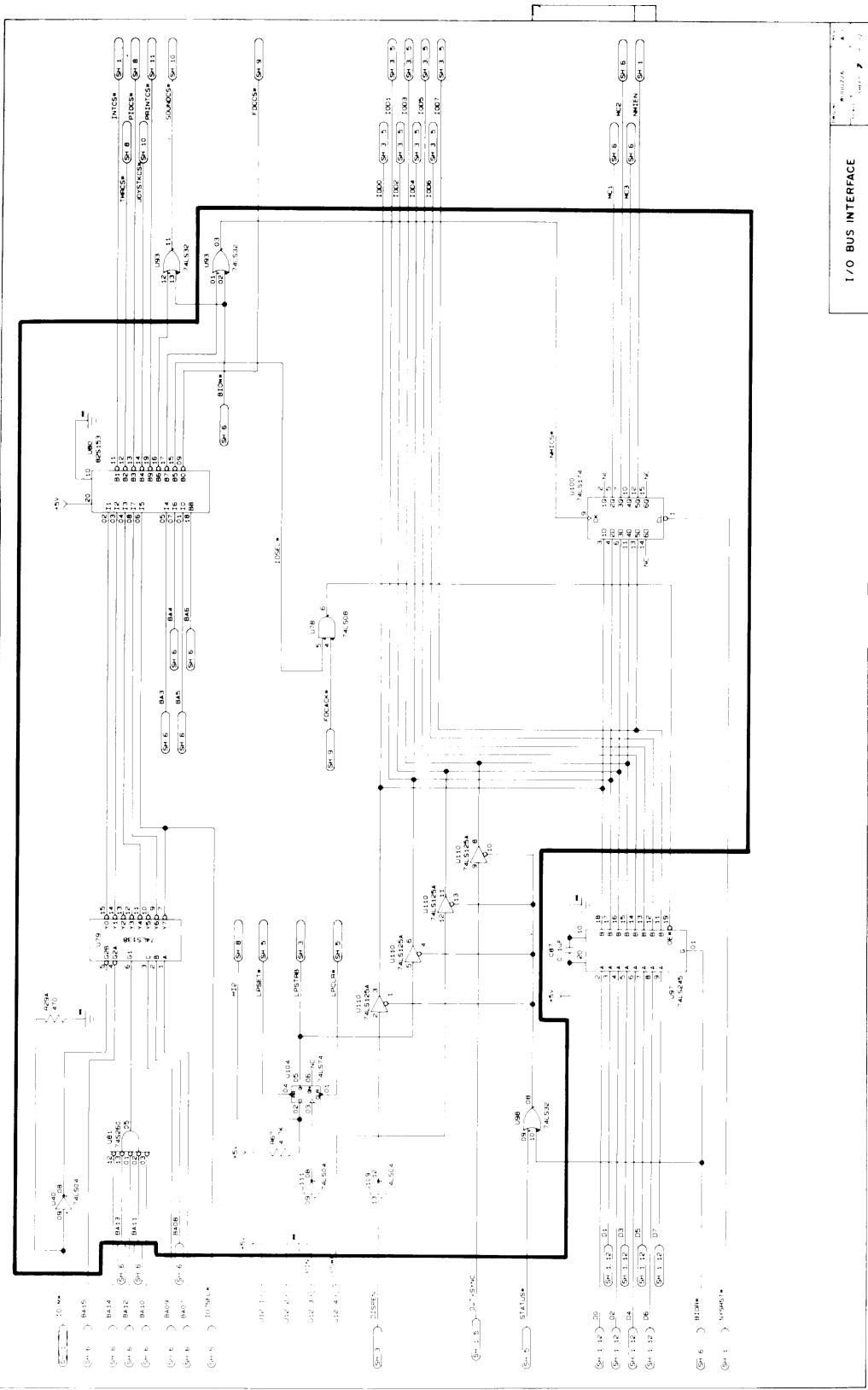


TANDY COMPUTER PRODUCTS

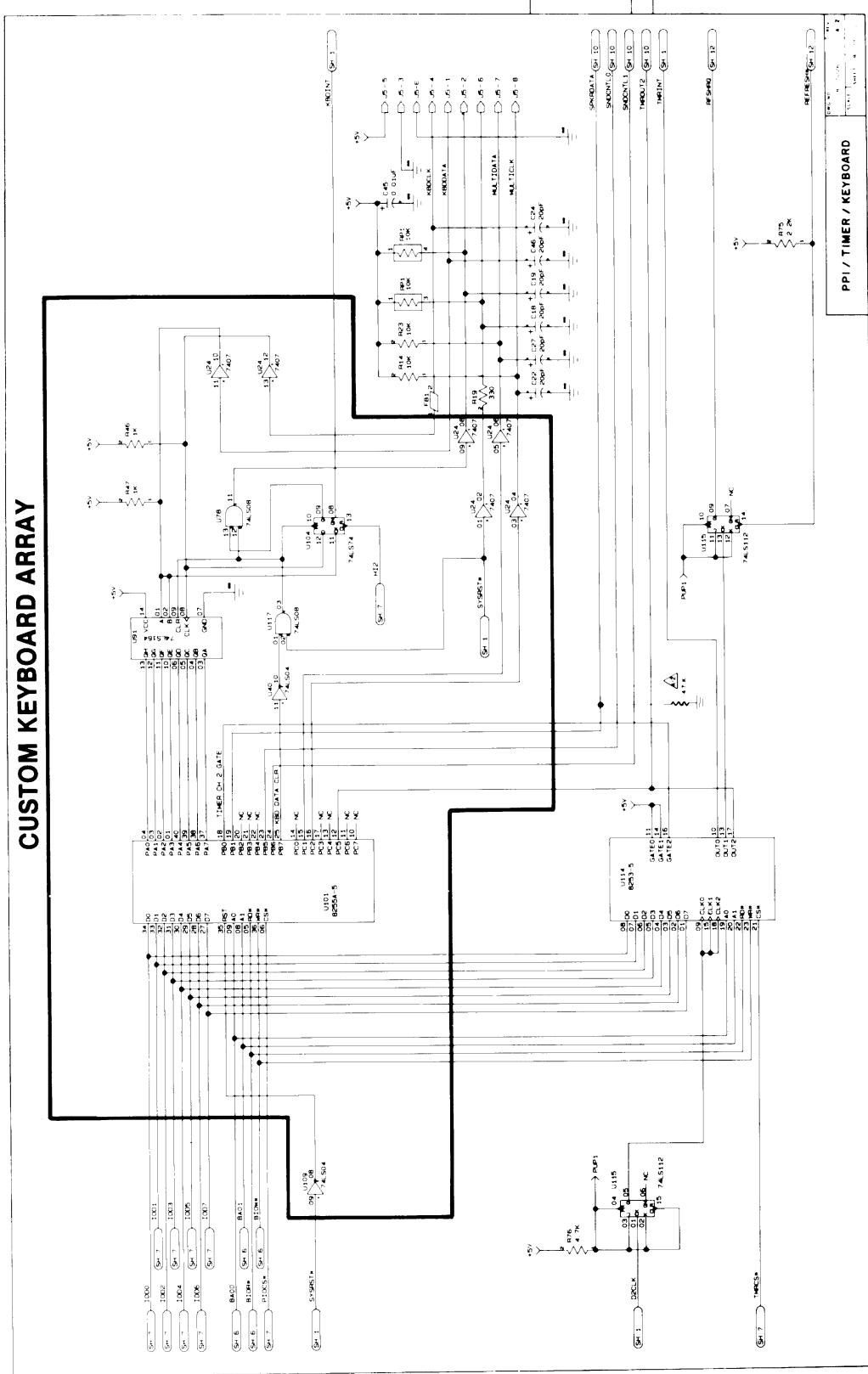


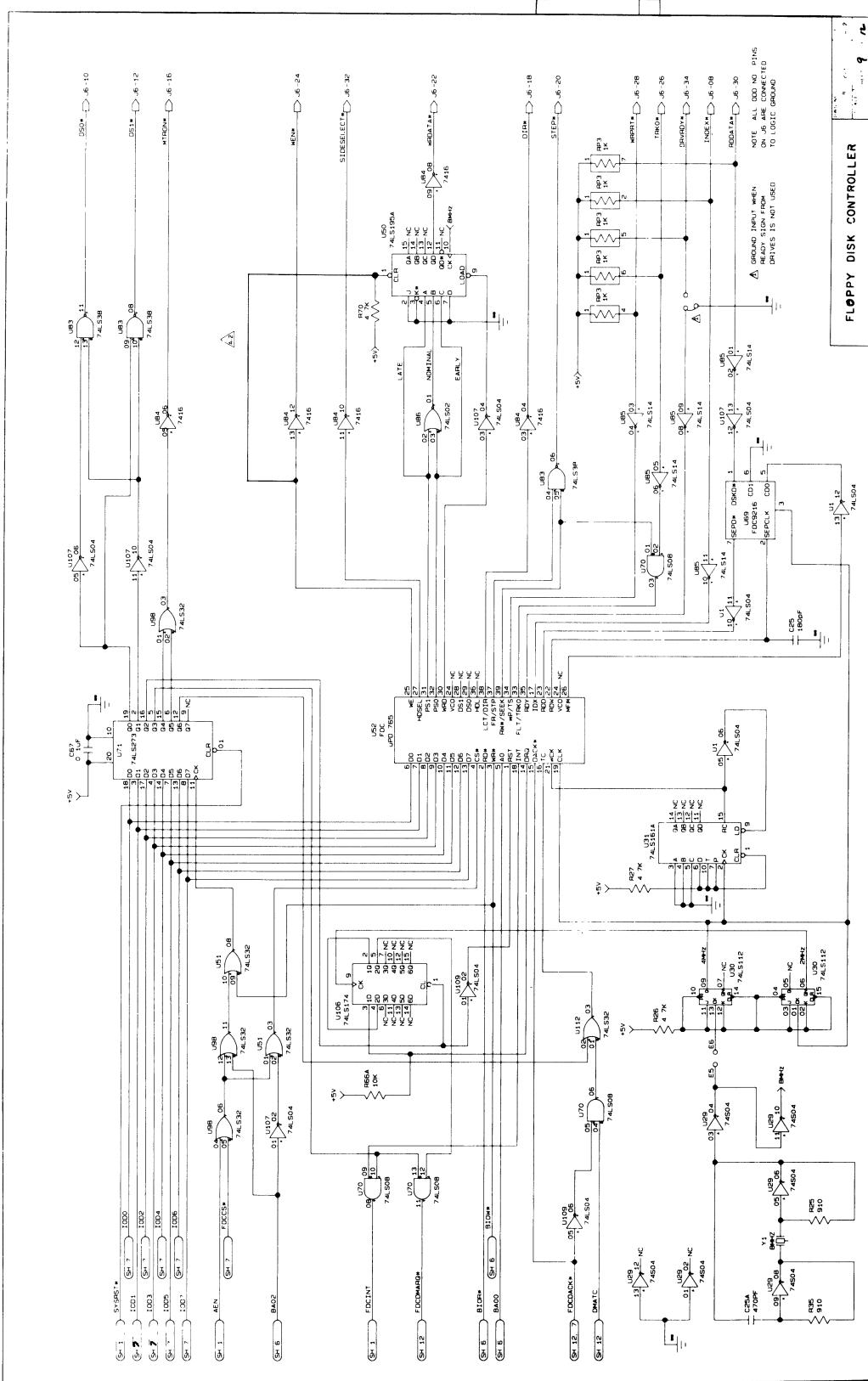
TANDY COMPUTER PRODUCTS

CUSTOM ADDRESS ARRAY



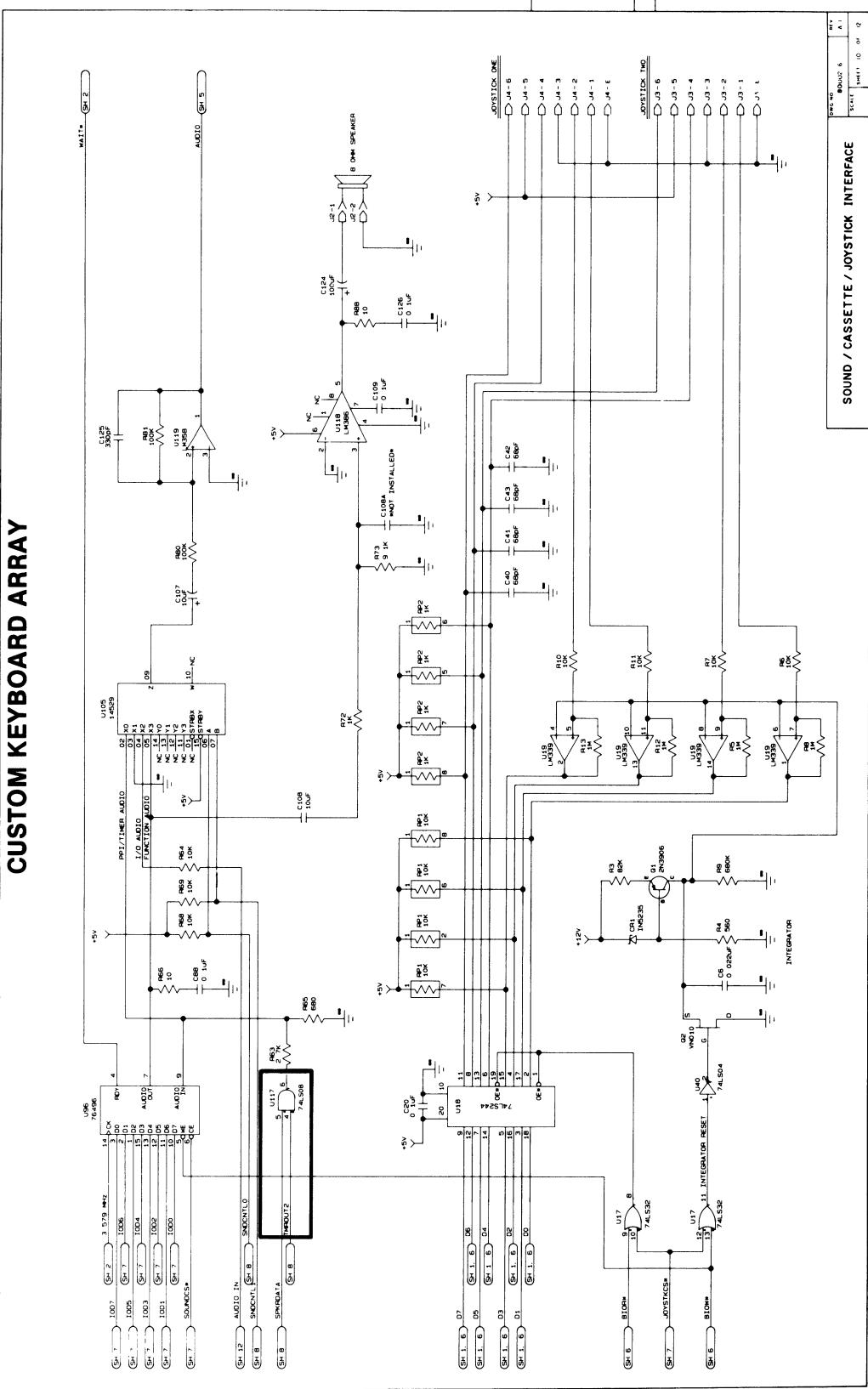
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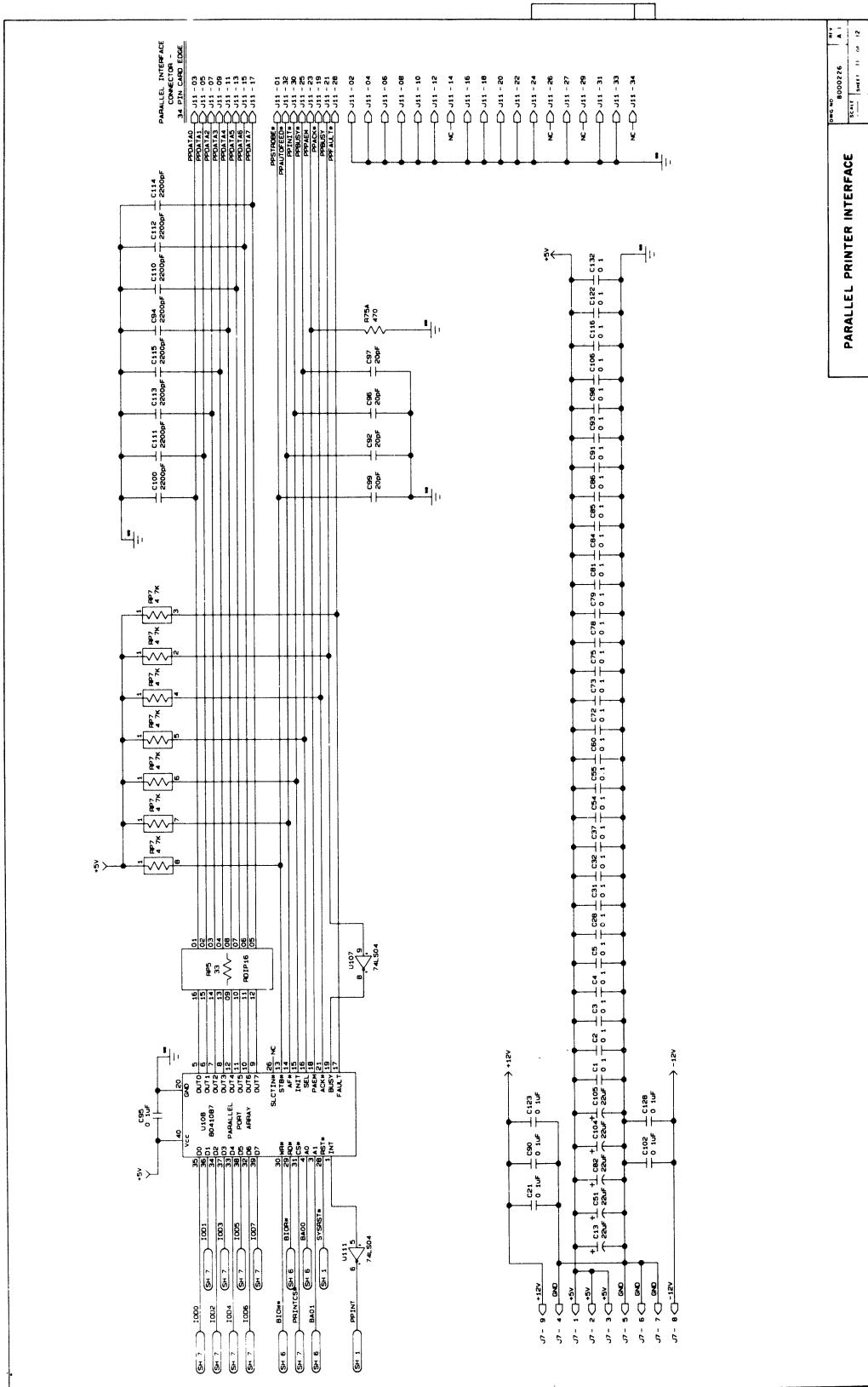


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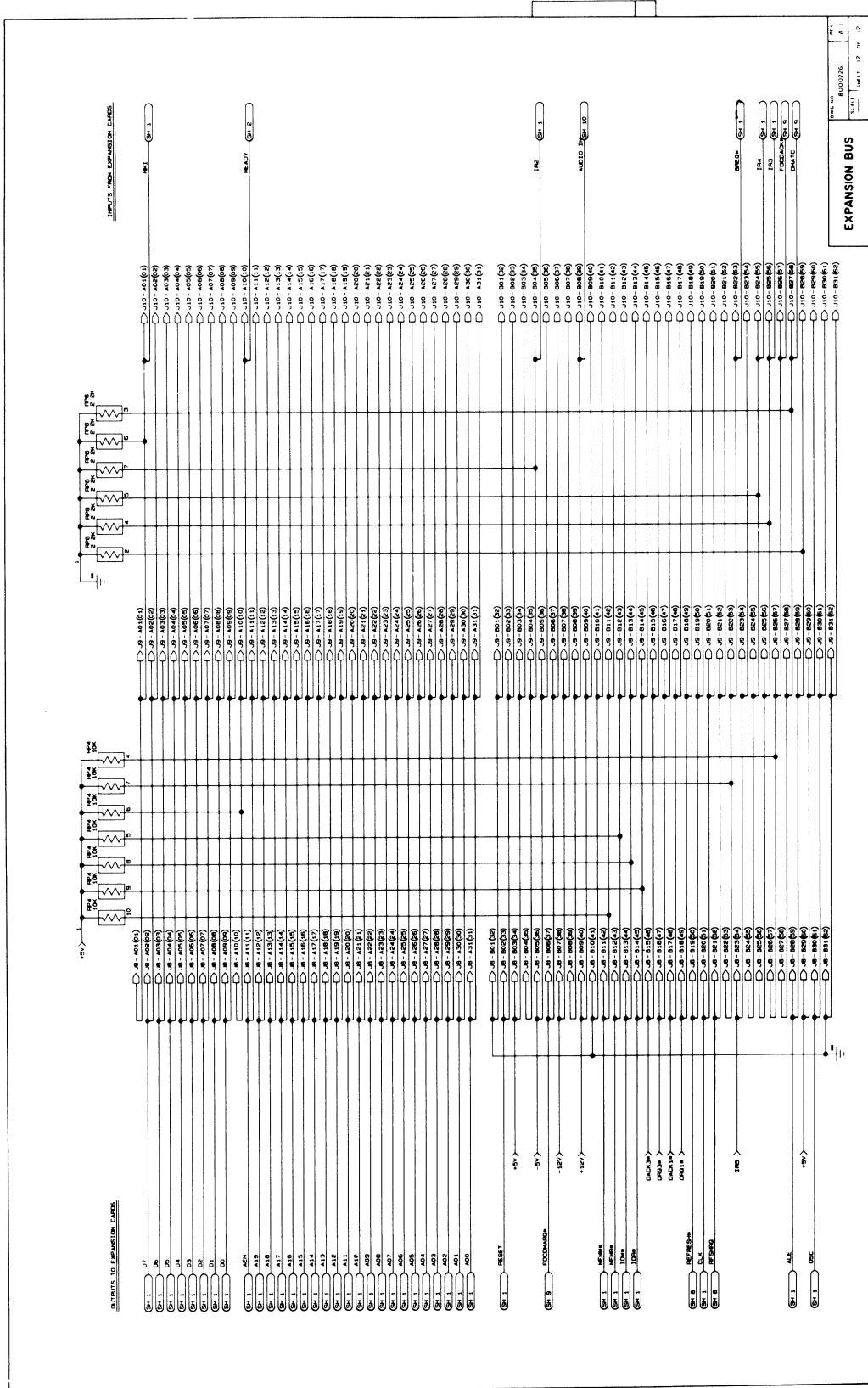
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CUSTOM KEYBOARD ARRAY

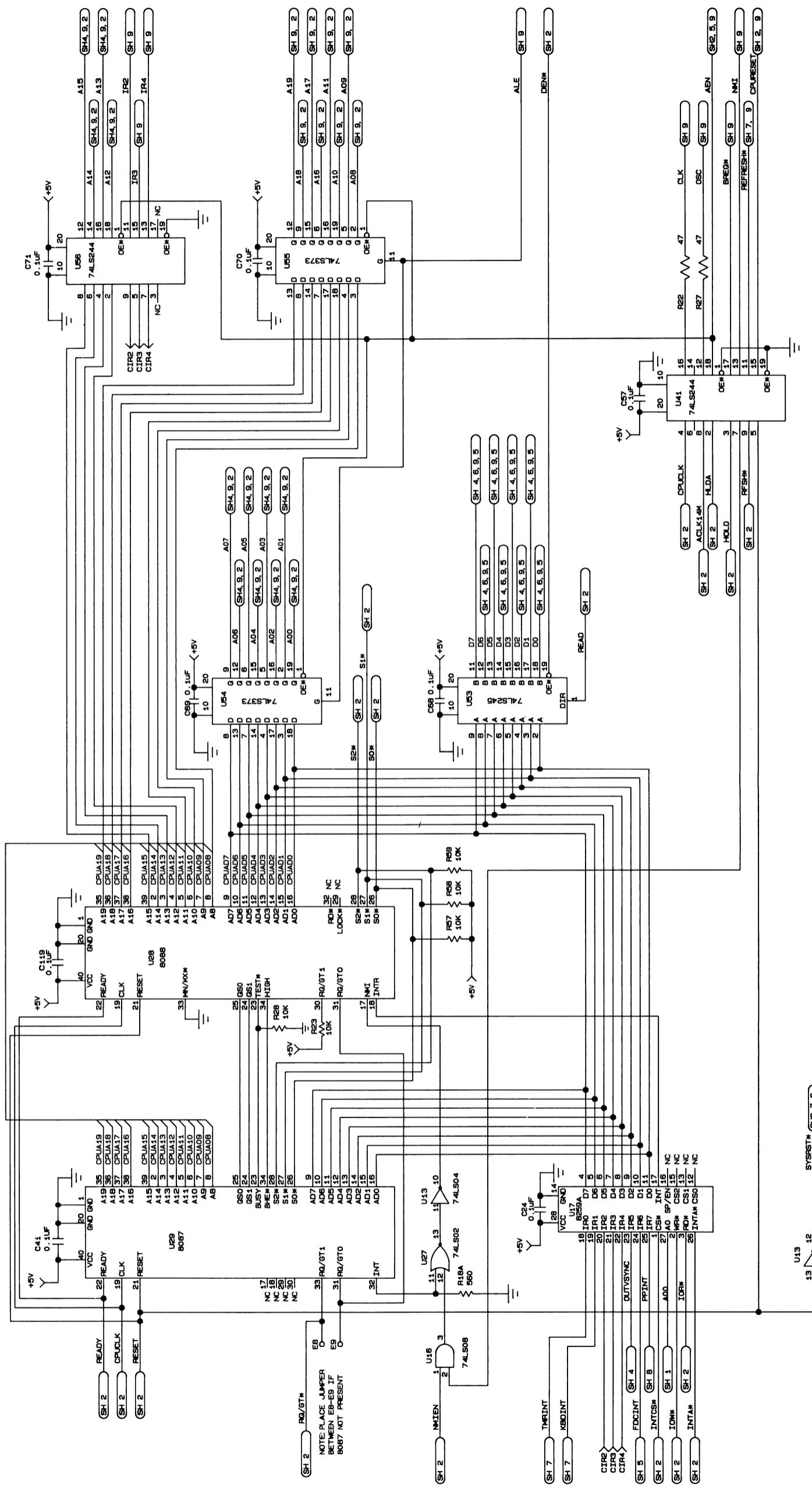


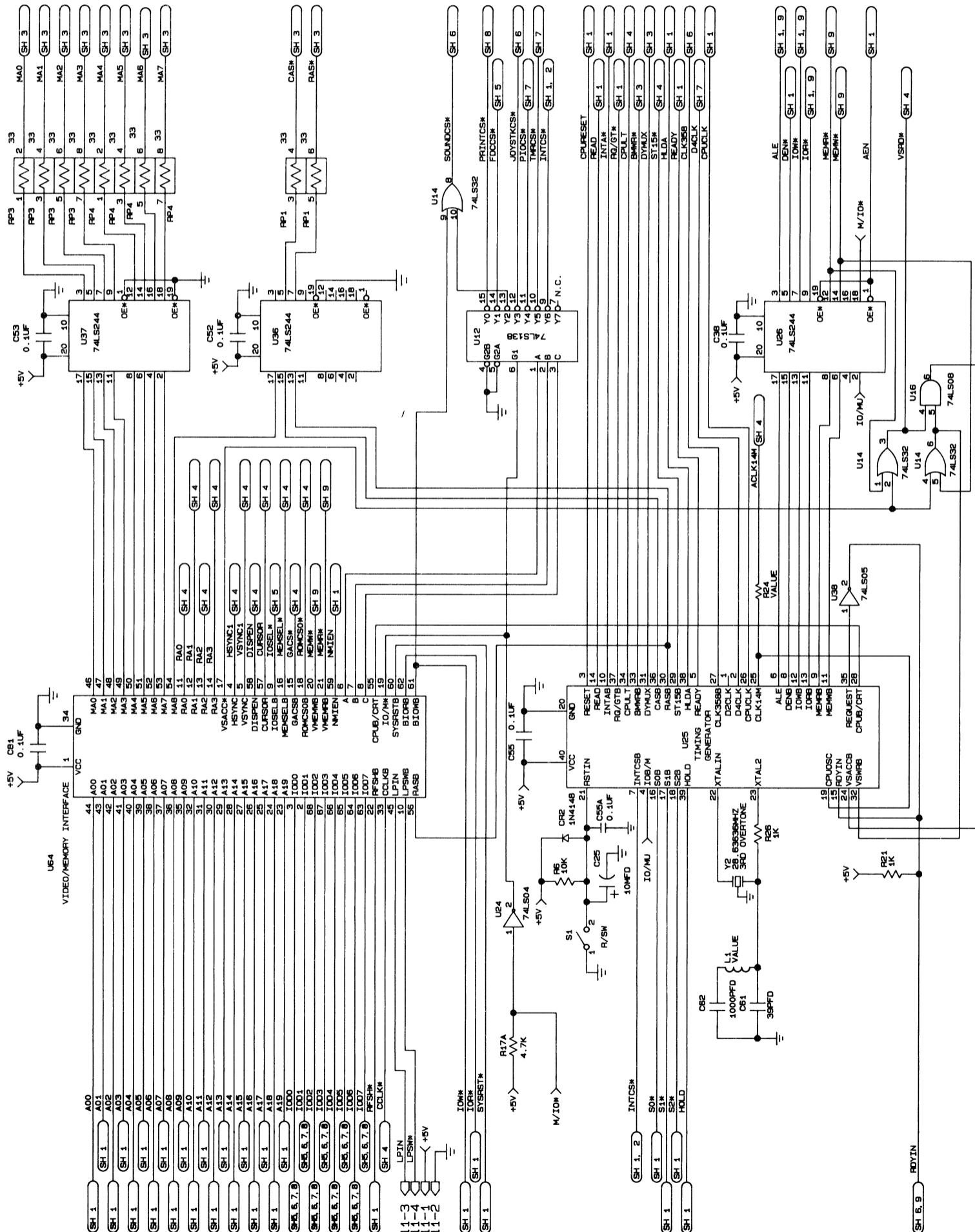
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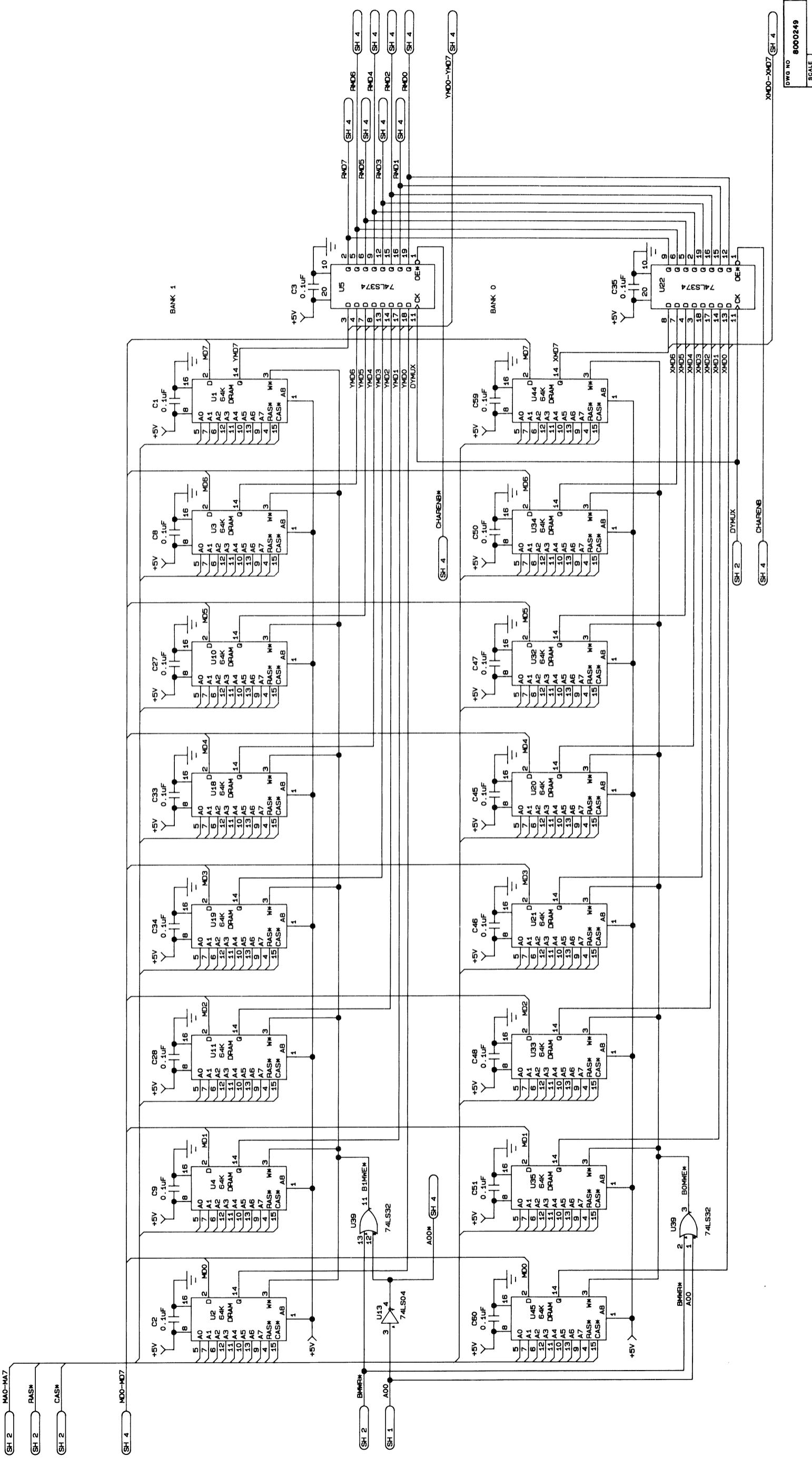


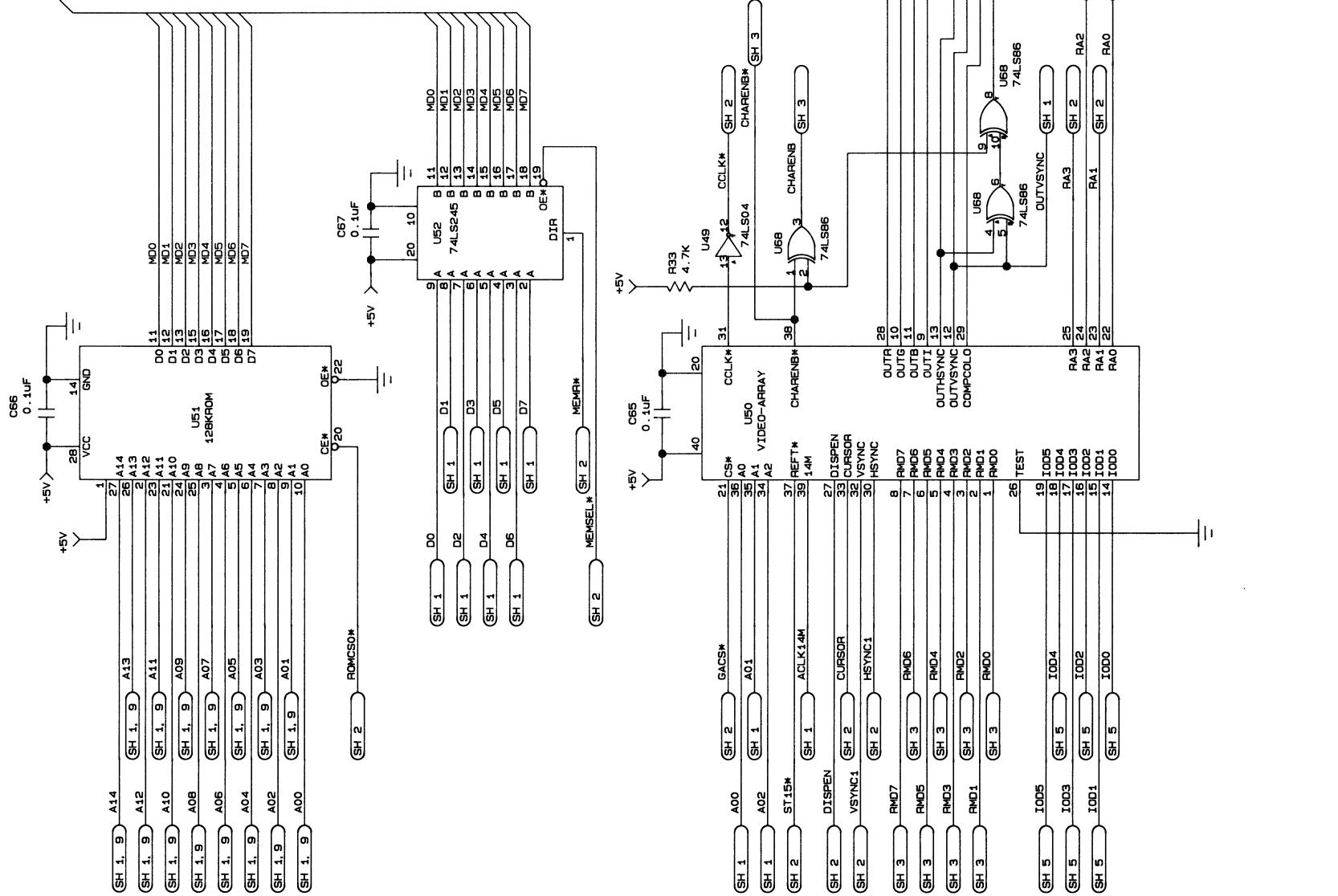
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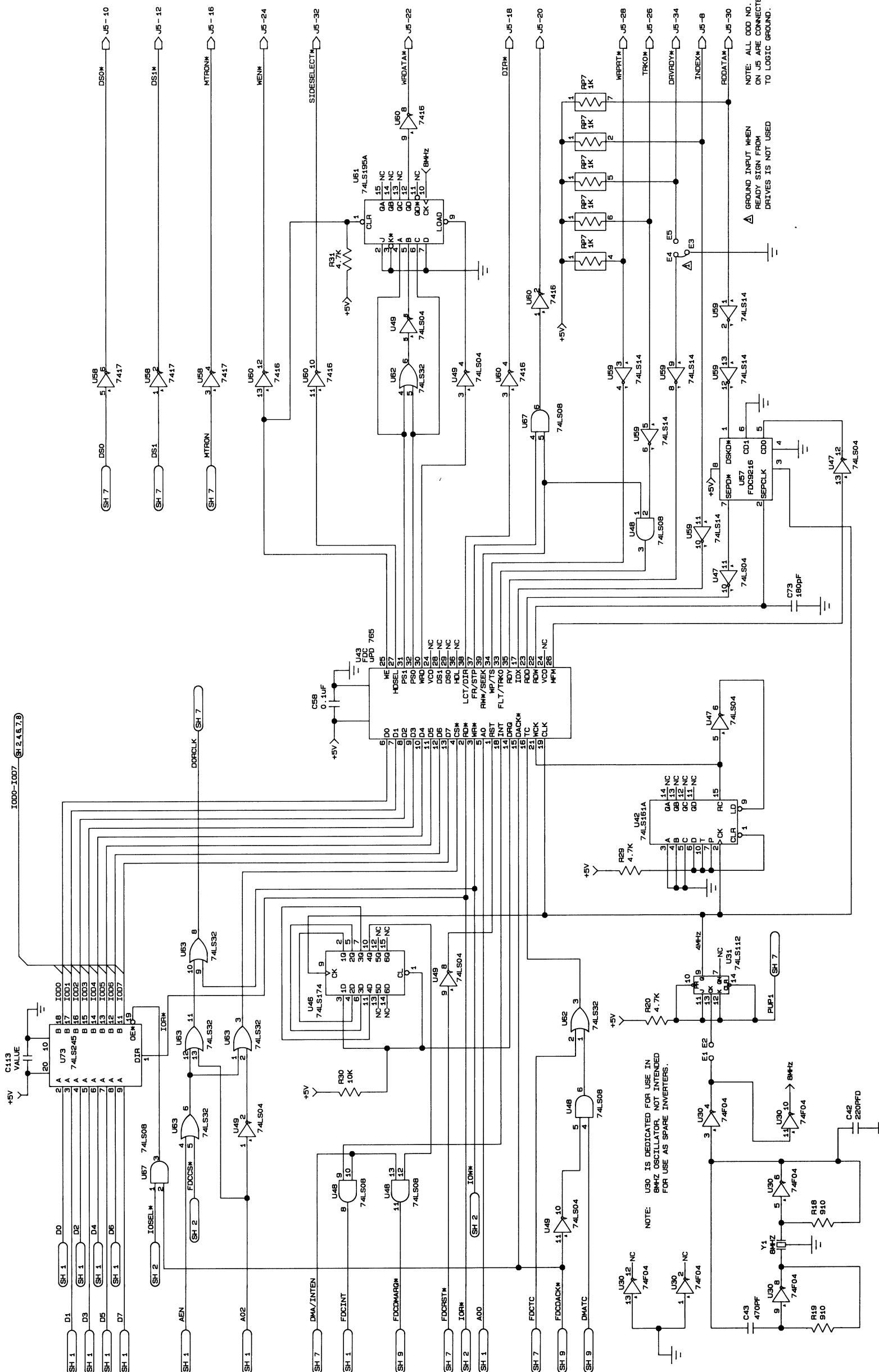


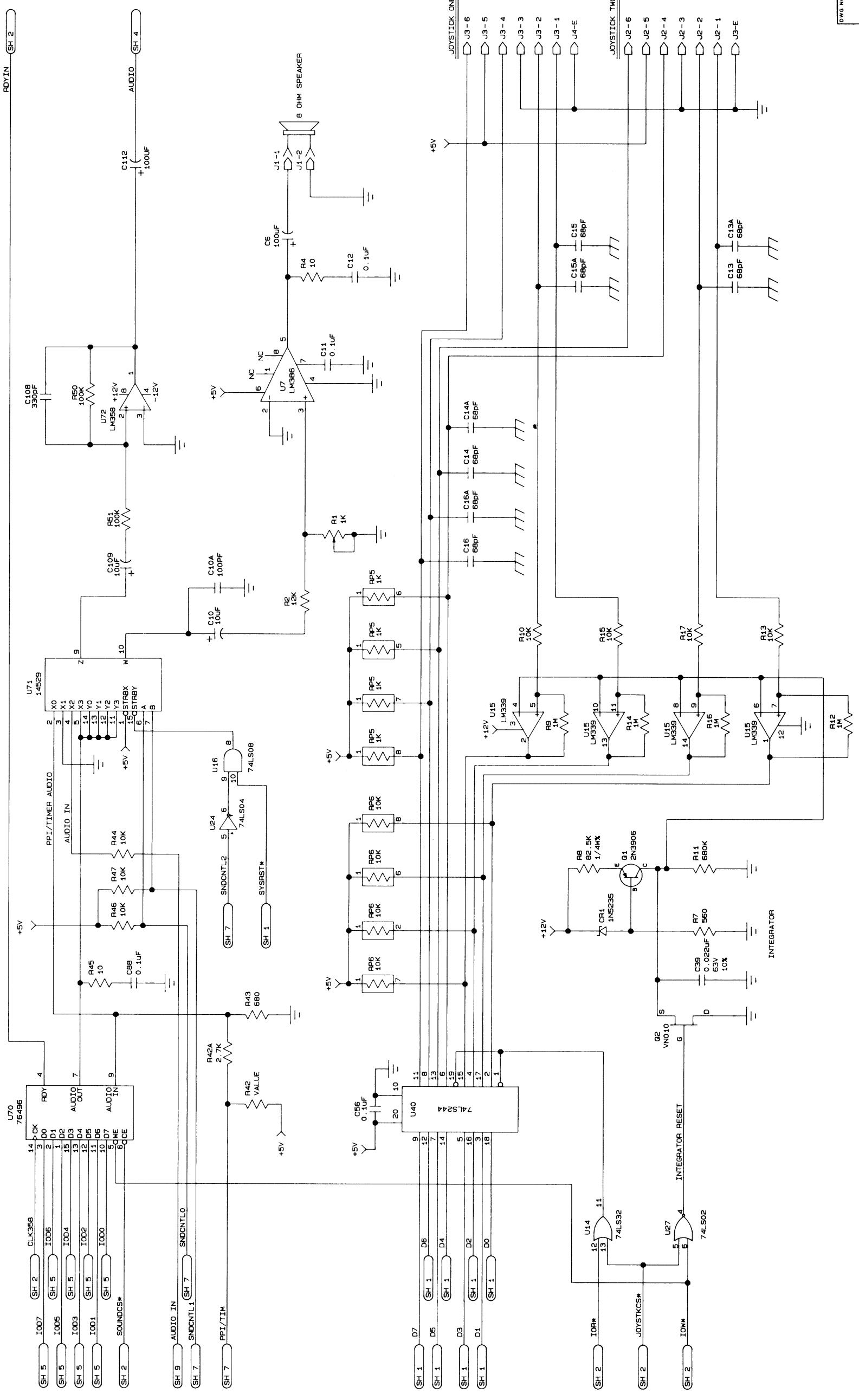


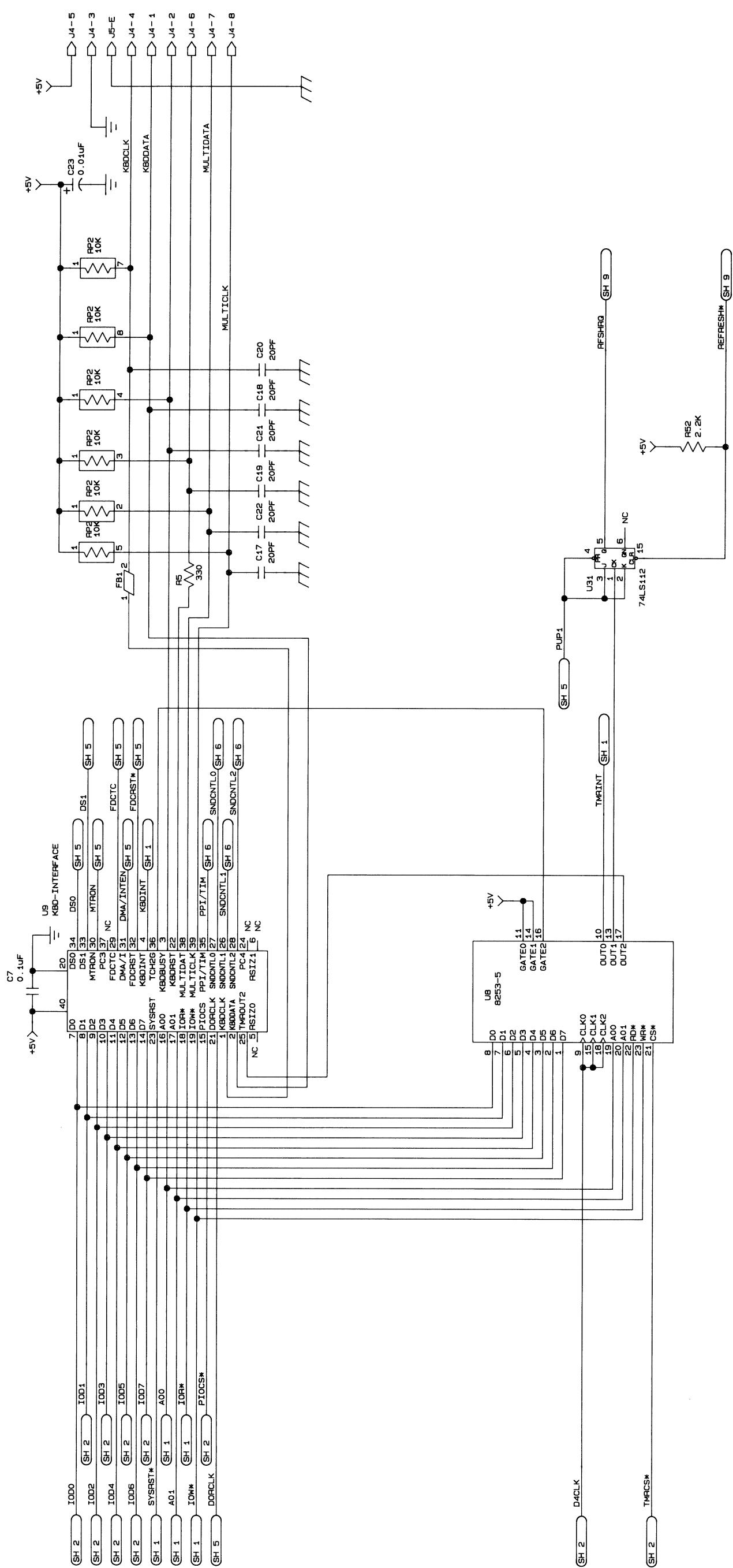
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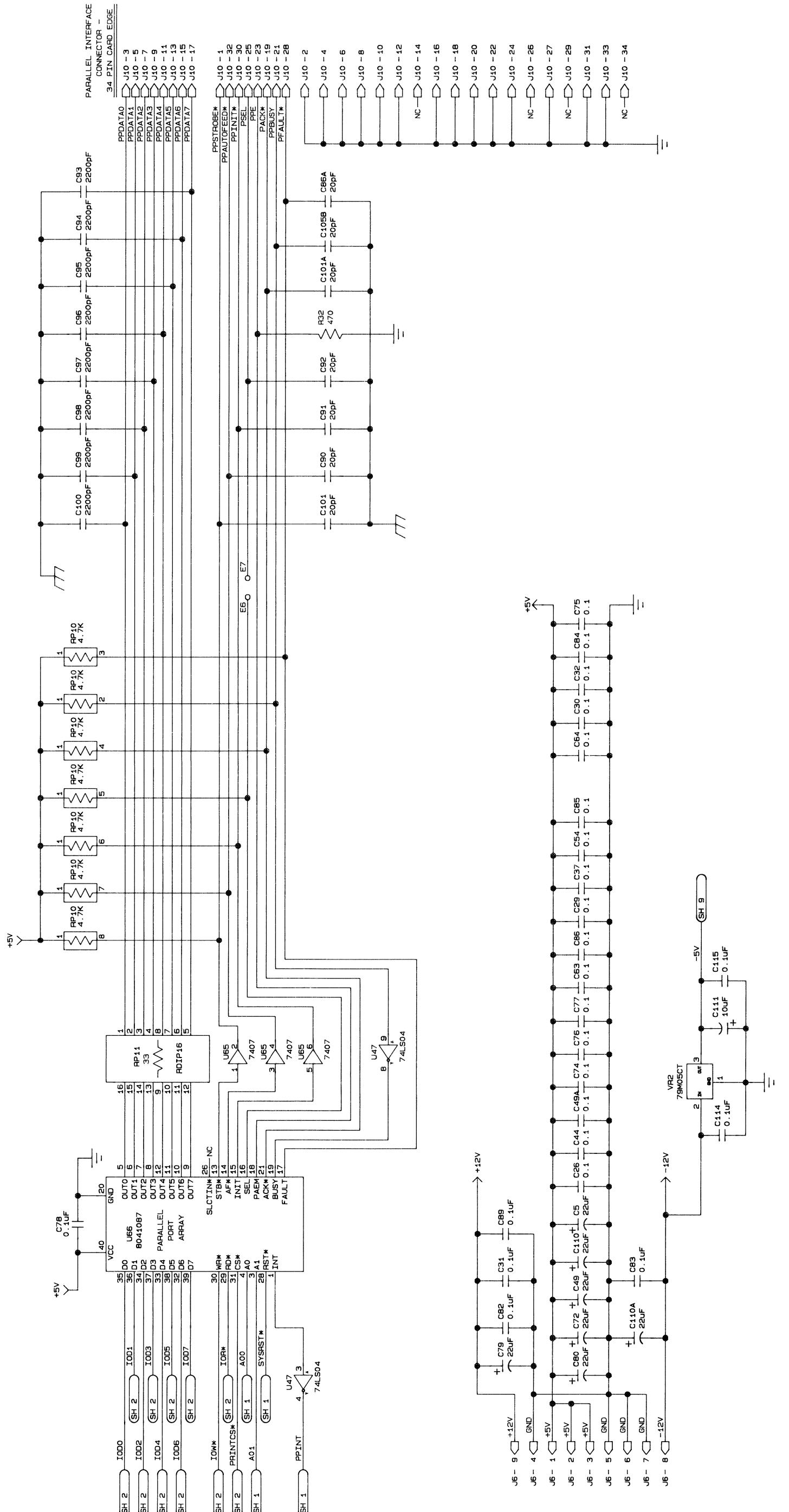


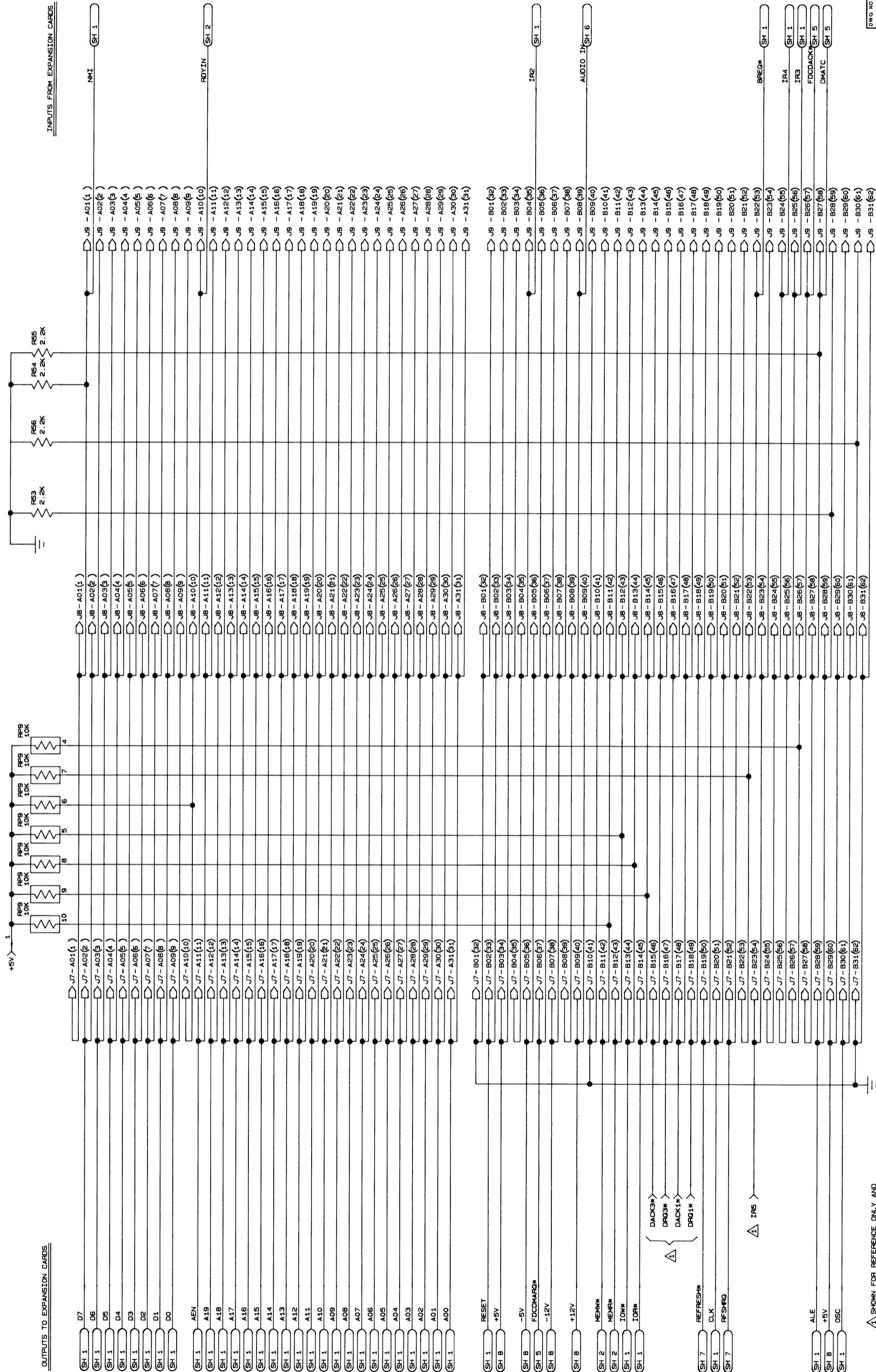












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