POKEY

CO12294

CONFIDENTIAL

REVISIONS			
SYM	DESCRIPTION	DATE	APPV'D
B	RELEASE PER ECN 5320	5-30-82	EW

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TITLE: POKEY CHIP

SIZE	DRAWING NO.	REV
A	CO12294	B

SCALE – SHEET 1 OF 41

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1. GENERAL DESCRIPTION:

There are four semi-independent audio channels, each with its own frequency, noise and volume control. Each channel has an eight bit "divide by N" frequency divider and an eight bit control register, which selects the noise (polynomial counter) content and volume.

There are six key scan lines(K0-K5), which holds a value from 00 to 3F. There are two sense lines. One of the sense lines is for the full decode of the six scan lines. The other sense line is for decoding only the codes (CTRL, SHIFT, and BREAK key).

There are eight pot ports for measuring input rise time. Each input has an eight bit counter which is clocked every TV line. Each input also has a dump transistor which is turned on or off by software.

There are three timers which use the audio channels. If start timer (STIMER) is enabled, the audio channels are reset.

There is a random number generator which is eight bits from a polynomial counter.

There is a serial I/O port. The serial port consists of a serial output line, a serial input line, a serial output clock line, and a bi-directional serial data clock line. Also there are control registers which are used to configure the serial port.

There are eight IRQ interrupts. They are BREAK key, OTHER key, SERIAL INPUT READY, SERIAL OUTPUT NEEDED, TRANSMISSION FINISHED, TIMER #4, TIMER #2, and TIMER #1. These interrupts can be enabled or disabled by software. There is also a register to read interrupt status.

2. AUDIO:

There are four semi-independent audio channels, each with its own frequency, noise, and volume control. Each channel has an eight bit "divide by N" frequency divider, controlled by an eight bit register (AUDFX). Each channel also has an eight bit control register (AUDCX) which selects the noise (polynomial counter) content and the volume.

All four frequency dividers can be clocked simultaneously from 64 KHZ or 15 KHZ by AUDCTL bit 0. Frequency dividers 1 and 3 can alternately be clocked from

1.79 MHZ by setting AUDCTL bits 5 and 6. Frequency dividers 2 and 4 can alternately be clocked with the output of dividers 1 and 3 by setting AUDCTL bits 4 and 3. This allows the following options: 4 channels of 8 bit resolution, 2 channels of 16 bit resolution, or 1 channel of 16 bit resolution and 2 channels of 8 bit resolution.

There are three polynomial counters (17 bit, 5 bit and 4 bit) used to generate random noise. The 17 bit poly counter can be reduced to a 9 bit poly counter by bit 7 of AUDCTL. These counters are clocked by 1.79 MHZ. Their outputs, however, can be sampled independently by the four audio channels at a rate determined by each channel's frequency divider. Thus each channel appears to contain separate poly counters clocked at its own frequency. This poly counter noise sampling is controlled by bits 5, 6, and 7 of each AUDCX register. Because the poly counters are sampled by the "divide by N" frequency divider, the output obviously cannot change faster than the sampling rate. In these modes (poly noise outputted), the dividers are therefore acting as "low pass" filter clocks, allowing only the low frequency noise to pass.

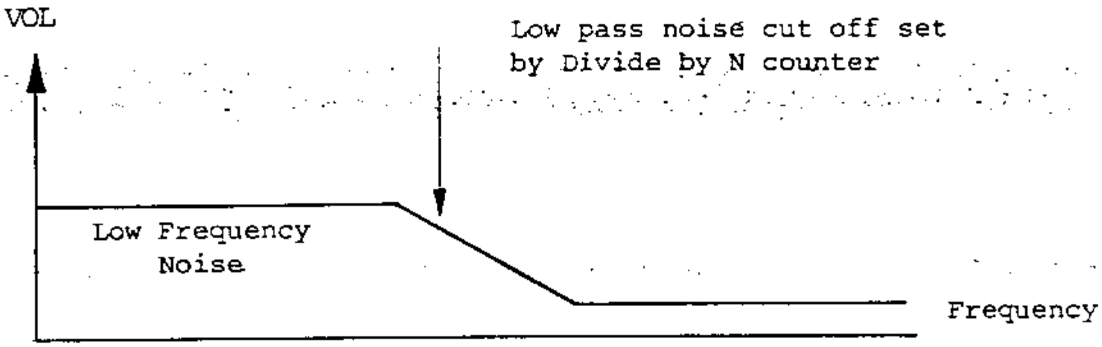
The output of the noise control circuit described above consists of pure tones (square wave type), or polynomial counter noise at a maximum frequency set by the "divide by N" counter (low pass clock). This output can be routed through a high pass filter if desired by use of bits 1 and 2 of AUDCTL.

The high pass filter consists of a "D" flip flop and an exclusive-OR Gate. The noise control circuit output is sampled by this flip flop at a rate set by the "High Pass" clock. The input and output of the Flip Flop pass through the exclusive-OR Gate. However, if it is lower than the clock rate, the flip flop output will tend to follow the input and the two exclusive-OR Gate inputs will mostly be identical (11 or 00) giving very little output. This gives the effect of a crude high pass filter, passing noise whose minimum frequency is set by the high pass clock rate. Only channels 1 and 2 have such a high pass filter. The high pass clock for channel 1 comes from the channel 3 divider. The high pass clock for channel 2 comes from the channel 4 divider. This filter is included only if bit 1 or 2 of AUDCTL is true.

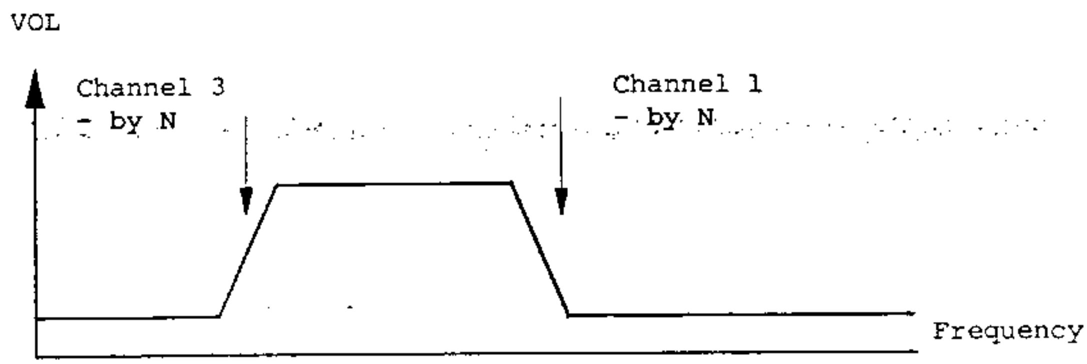
A volume control circuit is placed at the output of each channel. This is a crude 4 bit digital to analog converter that allows selection of one of 16 possible output current levels for a logic true audio input. A logic zero audio input to this volume circuit always gives an open circuit (zero current) output. The volume selection is controlled by bits 0 through 3 of AUDCX. "Volume Control only" mode can be invoked by forcing this circuit's audio input true with bit 4 of AUDCX. In this mode the dividers, noise counters, and filter circuits are all disconnected from the channel output. Only the volume control bits (0 to 3 of AUDCX) determine the channel output current.

The audio output of any channel can be completely turned off by writing zero to the volume control bits of AUDCX. All ones give maximum volume.

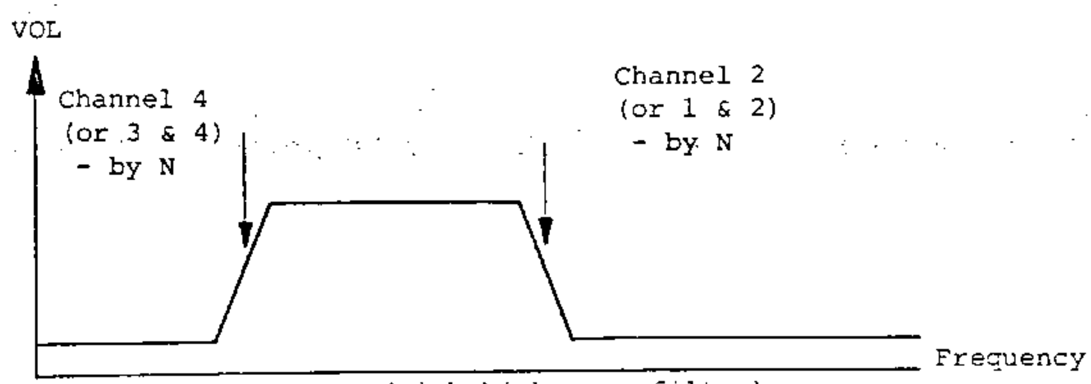
AUDIO NOISE FILTERS:



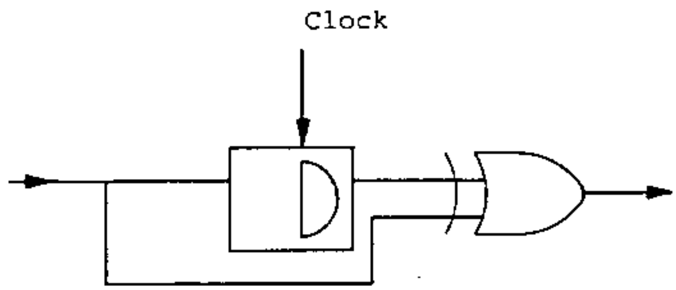
Any channel noise output (without high pass filter)



Channel 1 output (with high pass filter)



Channel 2 output (with high pass filter)



AUDCTL (Audio Control) (08): This address writes data into the Audio Mode Control Register. (Also see SKCTL two-tone bit 3 and notes).

D7	D6	D5	D4	D3	D2	D1	D0

D7 Change 17 bit poly into a 9 bit below poly.

D6 Clock Channel 1 with 1.79 MHZ, instead of 64 KHZ.

D5 Clock Channel 3 with 1.79 MHZ, instead of 64 KHZ.

D4 Clock Channel 2 with Channel 1, instead of 64 KHZ (16 BIT).

D3 Clock Channel 4 with Channel 3, instead of 64 KHZ (16 BIT).

D2 Insert Hi Pass Filter in Channel 1, clocked by Channel 3. (See section II.)

D1 Insert Hi Pass Filter in Channel 2, clocked by Channel 4.

D0 Change Normal 64 KHZ frequency, into 15 KHZ.

Exact Frequencies: The frequencies given above are approximate. The Exact Frequency (Fin) that clocks the divide by N counters is given below (NTSC only, PAL different).

Fin (Approximate)	Fin (Exact)		
1.79 MHZ	1.78979 MHZ	-	Use modified formula for Fout
64 KHZ	63.9210 KHZ		
15 KHZ	15.6999 KHZ	-	Use normal formula for Fout

The Normal Formula for output frequency is:

$$Fout = Fin/2N$$

Where N = the binary number in the frequency register (AUDF), plus 1 (N=AUDF+1).
The MODIFIED FORMULA should be used when Fin = 1.79 MHZ and a more exact result is desired:

$$Fout = \frac{Fin}{2(AUDF + M)}$$

Where: M = 4 if 8 bit counter (AUDCTL bit 3 or 4 = 0)
M = 7 if 16 bit counter (AUDCTL bit 3 or 4 = 1)

AUDF1, AUDF2, AUDF3, AUDF4, (Audio Frequency) (00, 02, 04, 06):

These addresses write data into each of the four Audio Frequency Control Registers. Each register controls a divide by "N" counter.

D7	D6	D5	D4	D3	D2	D1	D0	"N"
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1	2
ETC.								
1	1	1	1	1	1	1	1	256

Note: "N" is one greater than the binary number in Audio Frequency Register AUDF(X).

AUDC1, AUDC2, AUDC3, AUDC4 (Audio Channel Control)(01, 03, 05, 07):

These addresses write data into each of the four Audio Control Registers. Each Register controls the noise content and volume of the corresponding Audio Channel.

	Noise Content or Distortion				Volume				
HEX	D7	D6	D5	D4	D3	D2	D1	D0	Divisor "N" set by audio frequency register.
0	0	0	0	0					- 17 BIT poly - 5 BIT poly - N
2	0	0	1	0					- 5 BIT poly - N - 2
4	0	1	0	0					- 4 BIT poly - 5 BIT poly - N
6	0	1	1	0					- 5 BIT poly - N - 2
8	1	0	0	0					- 17 BIT poly - N
A	1	X	1	0					- Pure Tone - N - 2
C	1	1	0	0					- 4 BIT poly - N
1	X	X	X	1					- Force Output (Volume only)
0					0	0	0	0	- Lowest Volume (Off)
8					1	0	0	0	- Half Volume
F					1	1	1	1	- Highest Volume

PITCH VALUES FOR THE MUSICAL NOTES-AUDCTL =0, AUDC = hex AX

		AUDF	
		Hex	Dec
HIGH NOTES	C	1D	29
	B	1F	31
	A# or Bb	21	33
	A	23	35
	G# or Ab	25	37
	G	28	40
	F# or Gb	2A	42
	F	2D	45
	E	2F	47
	D# or Eb	32	50
	D	35	53
	C# or Db	39	57
	C	3C	60
	B	40	64
	A# or Bb	44	68
	A	48	72
	G# or Ab	4C	76
	G	51	81
	F# or Gb	55	85
	F	5B	91
	E	60	96
	D# or Eb	66	102
	D	6C	108
	C# or Db	72	114
MIDDLE C	C	79	121
	B	80	128
	A# or Bb	88	136
	A	90	144
	G# or Ab	99	153
	G	A2	162
	F# or Gb	AD	173
	F	B6	182
	E	C1	193
	D# or Eb	CC	204
	D	D9	217
LOW NOTES	C# or Db	E6	230
	C	F3	243

3. KEYBOARD SCAN:

The $\overline{\text{K0}}$-$\overline{\text{K5}}$ lines hold a 6 bit value from 00 to 3 F. This allows for decoding 64 keys. With external CMOS (4052) chips, a key matrix is formed. The value of the key selected by the key matrix is returned on the $\overline{\text{KR1}}$ line.

Internal to the Pokey is a 6 bit binary counter, a 6 bit compare latch, and an 8 bit keycode latch. A control state machine does debouncing of the keys.

When the keyboard scanner is enabled by the SKCTL register, the binary counter begins to count, once per line. If the $\overline{\text{KR1}}$ line goes low, the value of the binary counter is transferred to compare latch. This will be the key code to be debounced. If $\overline{\text{KR1}}$ goes low before the next time the binary counter equals the compare latch then there are two keys depressed and both are ignored. If the binary counter equals the compare latch and KR1 is high, then the key is bouncing and is ignored, but if $\overline{\text{KR1}}$ is low then the key is valid and it is transferred to the keycode latch for reading by the CPU. An IRQ is also sent indicating the key is ready. As soon as $\overline{\text{KR1}}$ is low and the binary counter equals compare latch, the key is still depressed. As soon as $\overline{\text{KR1}}$ is high, then the key will be checked for debounce. The next time the binary counter equals the compare latch and $\overline{\text{KR1}}$ is high, then the key is debounced and another key can be looked for. But if $\overline{\text{KR1}}$ is low, then the key is bouncing and is assumed to be still pressed.

If the debounce is disabled, the Pokey forces the binary counter equal compare latch signal to a logic true value which will disable debounce.

$\overline{\text{KR2}}$ input is used to decode 3 keys. They are SHIFT, BREAK and CONTROL. They do not get debounced. They are decoded only at:

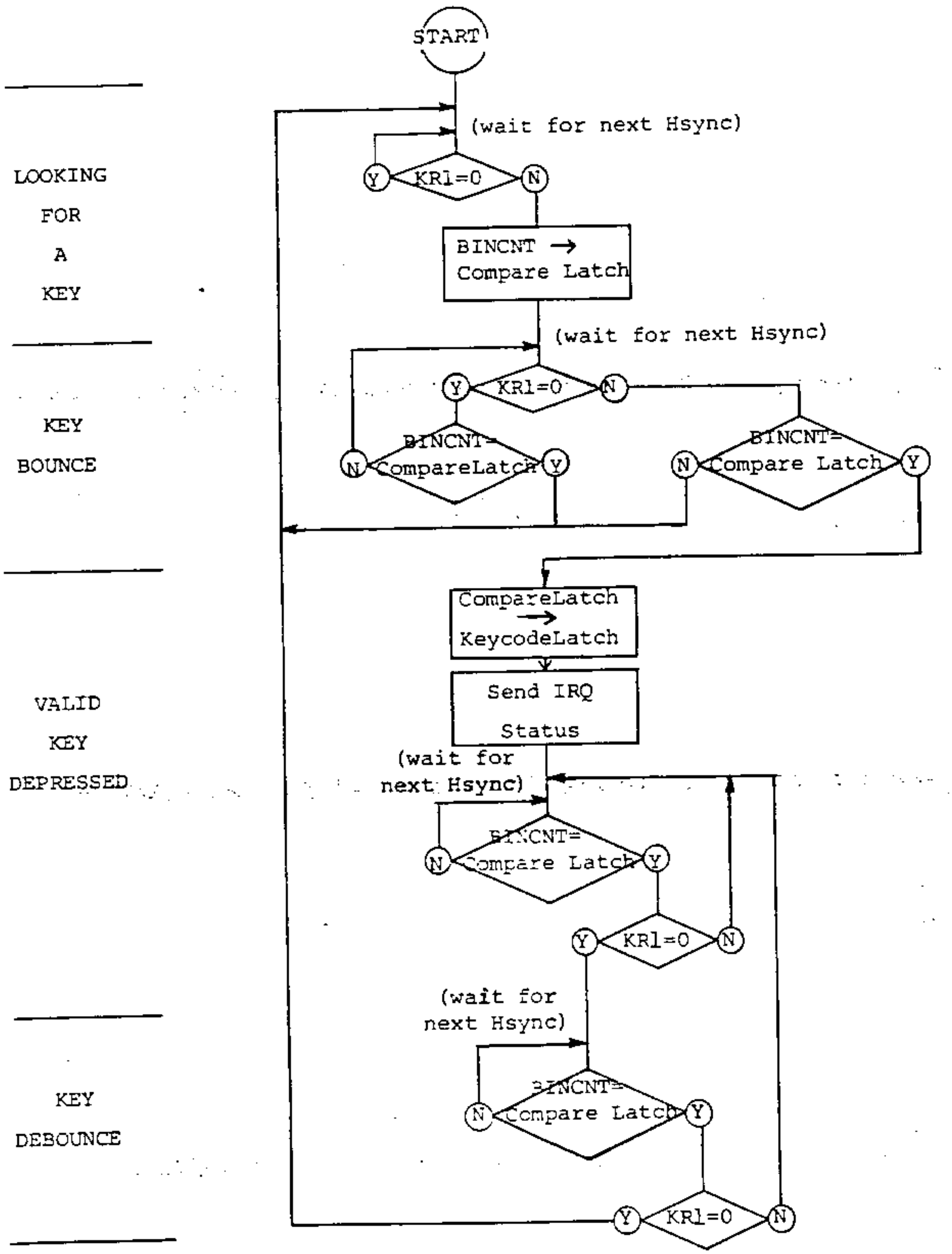
		$\overline{\text{K0}}$	$\overline{\text{K1}}$	$\overline{\text{K2}}$	$\overline{\text{K3}}$	$\overline{\text{K4}}$	$\overline{\text{K5}}$
BREAK	=	1	1	1	1	0	0
SHIFT	=	1	1	1	1	0	1
CONTROL	=	1	1	1	1	1	1

KBCODE (Keyboard Code) (09): This address reads the Keyboard Code, and is usually read in response to a Keyboard Interrupt (IRQ and bits 6 or 7 of IRQST). See IRQEN for information on enabling keyboard interrupts. See SKCTL bits 1 and 0 for key scan and debounce enable.

D7	D6	D5	D4	D3	D2	D1	D0

D7 - Control Key
D6 - Shift Key

KEYSCAN CONTROL FLOW CHART



If Debounce Disable is in effect

then BINCNT = Compare Latch

4. POT PORTS

There are eight pot input lines. Each line has a dump transistor and an eight bit latch. There is a binary counter that will count to 228. The counter is reset by strobing POTGO, which also releases the dump transistors. It also starts the binary counter to count once per line. The pot lines now will start to charge. When each line reaches a logic one, it will cause the counter value to be latched into its corresponding latch to be read by the CPU. When the counter reaches 228, the dump transistor is turned back on to pull the pot lines back to ground. The value in the latches will remain until the next POTGO strobe. To operate pot port:

1) $03 -> SKCTL ; Turn off init.

2) During Vblank service routine, perform the following instructions:

    A) Read POT0 to POT7 registers

    B) Write to POTGO register (strobe)

There is an ALLPOT register which allows the logic value of each pot line to be read by the CPU. The main use of Allpot is in the fast scan mode. This is done by:

1) Place Pokey in fast scan mode. (SEE SKCTLS)

2) Write to POTGO address.

3) Wait four cycles of computer clock.

4) Now the Allpot register can be read.

NOTE: This address (as well as the fast scan mode) is useful only when the charging capacitors on the P0 - P7 PADS are removed, unless the pads are driven by buffer drivers.

POT0 - POT7 (Pot Values)(00 - 07): These addresses read the value (0 to 228) of 8 pots (paddle controllers) connected to the 8 lines pot port. The paddle controllers are numbered from left to right when facing the console keyboard. Turning the paddle knob clockwise results in decreasing pot values. The values are valid only after 228 TV lines following the "POTGO" command described below or after ALLPOT changes.

D7	D6	D5	D4	D3	D2	D1	D0

Each Pot Value (0-228)

ALLPOT (All Pot Lines Simultaneously)(08): This address reads the present digital value of the eight line pot port.

	D7	D6	D5	D4	D3	D2	D1	D0
Pot number:	7	6	5	4	3	2	1	0

0 = Pot register value is valid.
1 = Pot register value is not valid.

8 Pot Line States

POTGO (Start Pot Scan) (0B):

No Data Bits Used

This write address starts the pot scan sequence. The pot values (POT0 - POT7) should be read first. This write strobe is then used causing the following sequence:

1) Scan Counter cleared to zero.
2) Capacitor dump transistors turned off.
3) Scan Counter begins counting.
4) Counter value captured in each of 8 registers (POT0 - POT7) as each pot line crosses trigger voltage.
5) Counter reaches 228, capacitor dump transistors turned on.

5. TIMERS:

Three of the audio channels can be used as timers. Audio channels 1, 2, and 4 are the channels that will cause IRQ interrupts for the timers. If interrupts are enabled, the interrupts will be caused by the audio channel crossing zero. The audio channel divide can be set to their "AUDF" value by strobing STIMER register. By strobing STIMER, the audio outputs are forced to a known state which are logic high for channels 1 and 2, and logic low for channels 3 and 4.

STIMER (Start TIMER) (09):

NOT USED

6. RANDOM NUMBER GENERATOR:

There is a seventeen bit polynomial counter that the CPU can read eight bit of the counter. The polynomial counter can be changed to nine bits by use of AUDCTL. If the Pokey is in the initial state (see SKCTLS), the counter is set to all ones state, therefore, the CPU will read $FF.

RANDOM (Random Number Generator) (0A): This address reads the high order 8 bits of a 17 bit polynomial counter (9 bit, if bit 7 of AUDCTL = 1).

D7	D6	D5	D4	D3	D2	D1	D0

7. SERIAL PORT

The serial port consists of a serial data output (transmission) line, a serial data input (receiver) line, a serial output clock line, a bi-directional serial data clock line, and other miscellaneous control lines described in the Operating System Manual. Data is transmitted and received as 8 bits of serial data preceded by a logic zero start bit, and succeeded by a logic true stop bit. Input and output clocks are equal to the baud (bit) rate, not 16 times baud rate. Transmitted data changes when the output clock goes true. Received data is sampled when the input clock goes to zero.

Serial Output: The transmission sequence begins when the processor writes 8 bits of parallel data into the serial output register (SEROUT). When any previous data byte transmission is finished the hardware will automatically transfer new data from (SEROUT) to the output shift register, interrupt the processor to indicate an empty (SEROUT) register (ready to be reloaded with the next byte of data), and automatically serially transmit the shift register contents with start-stop bits attached. If the processor responds to the interrupt, and reloads SEROUT before the shift register is completely transmitted, the serial transmission will be smooth and continuous.

Output data is normally transmitted as logic levels (+4V= true, 0V= false). Data can also be transmitted as two tone information. This mode is selected by bit 3 of SKCTL. In this mode audio channel 1 is transmitted in place of logic true, and audio channel 2 in place of logic zero. Channel 2 must be the lower tone of the tone pair.

The processor can force the data output line to zero (or to audio channel 2, if in two tone mode) by setting bit 7 of SKCTL. This is required to force a break (10 zeros) code transmission.

Serial Output Clock: The serial output data always changes when the serial output clock goes true. The clock then returns to zero in the center of the output data bit time.

The baud (bit) rate of the data and clock is determined by audio channel 4 audio channel 2, or by the input clock, depending on the serial mode selected by bits 4, 5, and 6 of SKCTL. (See chart at end of this section.)

Serial Input: The receiving sequence begins when the hardware has received a complete 8 bit serial data word plus start and stop bits. This data is automatically transferred to the 8 bit parallel input register (SERIN), and the processor is interrupted to indicate an input data byte ready to read in SERIN. The processor must respond to this interrupt, and read SERIN, before the next input data word reception is complete, otherwise an input data "over-run" will occur. This over-run will be indicated by bit 5 of SKSTAT (if bit 5 of IRQST is not RESET (true) before next input complete), and means input data has been lost. This bit should be tested whenever SERIN is read. Bit 7 of SKSTAT should also be tested to detect frame errors caused by extra (or missing) data bits.

Direct Serial Input: The serial data input line can be read directly by the microprocessor if desired, ignoring the shift register, by reading bit 4 of SKSTAT.

Bi-Directional Clock: This clock line is used to either receive a clock from an external clock source for clocking transmitted or received data, or is used to supply a clock to external devices indicating the transmit or reception rate. This clock line direction is determined by the serial mode selected by bits 4, 5, and 6 of SKCTL. (See mode chart at the end of this section.) Transmitted data changes on the rising edge of this clock. Received data is sampled on the trailing edge of this clock.

Asynchronous Serial Input: Unclocked serial data (at an approximately known (+5%) rate) can be received in the asynchronous modes. The receive (input) shift register is clocked by audio channel 4. Channels 3 and 4 should be used together (AUDCTL bit 3 = 1) for increased resolution. In asynchronous modes, channels 3 and 4 are reset by each start bit at the beginning of each serial data byte. This allows the serial data rate to be slightly different from the rate set by channels 3 and 4.

Serial Mode Control: There are 6 useful modes (of the possible 8) controlled by bits 4, 5, and 6 of SKCTL. These are described on the next page.

Note that two tone output (bit 3 of SKCTL) may be used in any of these modes except for the bottom pair. This is because channel 2 is used to set the output transmit rate and is therefore not available for one of the two tones.

Note that the output clock rate is identical to the output data rate.

SKCTL (Serial Port Control) (0F): This address writes data into the register that controls the configuration of the serial port, and also the Fast Pot Scan and Keyboard Enable.

D7	D6	D5	D4	D3	D2	D1	D0

(Bits perform the functions shown below when true.)

D7 Force Break (force serial output to zero (space))*

D6 \
D5 Serial Port Mode Control (see mode chart on next page).
D4 /

D3 Two Tone (Serial output transmitted as two tone signal instead of logic true/false.)

D2 Fast Pot (Fast Pot Scan. The Pot Scan Counter completes its sequence in two TV line times instead of one frame time. The capacitor dump transistors are completely disabled.)

D1 Enable Key Scan (Enables Keyboard Scanning circuit)

D0 Enable Debounce (Enables Keyboard Debounce circuits)

D0-D1 (Both Zero) Initialize (State used for testing and initializing chip)**

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*NOTE: When powered on, serial port output may stay low even if this bit is cleared. To get S. P. high (mark), send a byte out (recommend 00 or FF).

**NOTE: There is no original power on state. Pokey has no reset pin.

Force Break

|D7|D6|D5|D4|D3|D2|D1|D0|

SKCTL REGISTER

Pot scan and keyboard CTRL

D3 — Two Tone Control

D6, D5, D4 — Mode Control Bits

A = asynchronous

D6	D5	D4	Out Rate	Out Clock	In Rate	Bi-Dir Clock	Comments
0	0	0	ext	ext	ext	ext input	Trans. & Receive rates set by external clock. Also internal clock phase reset to zero.
0	0	1	ext	ext	chan 4 A	ext input	Trans. rate set by external clock. Receive asynch. (ch. 4) (CH3 and CH4)
0	1	0	chan 4	chan 4	chan 4	chan 4 output	Trans. & Receive rates set by Chan. 4. Chan. 4 output on Bi-Directional clock line.
0	1	1	CH4 A	CH4 A	CH4 A	input	Not Useful
1	0	0	chan 4	chan 4	ext	ext input	Trans. Rate Set by Chan. 4 Receive Rate set by External Clock.
1	0	1	CH4 A	CH4 A	CH4 A	input	Not Useful
1	1	0	Chan 2	Chan 2	Chan 2	Chan 4 Output	Trans. rate set by chan. 2 Recieve rate set by chan. 4 Chan. 4 out on Bi-Direct. Clock line.
1	1	1	Chan 2	Chan 2	Chan 4 A	Input not used	Trans. Rate set by Chan. 2. Receive async. (chan 3&4) Bi-Dir. Clock not used (Tri-state condition)

Two tone (bit3) not useable in these modes

SKSTAT (Serial Port-Keyboard Status) (0F): This address reads the status register giving information about the serial port and keyboard.

D7	D6	D5	D4	D3	D2	D1	D0

(Bits are normally true and provide the following information when zero.)

D7 = 0 = Serial Data Input Frame Error
D6 = 0 = Keyboard Over-run
D5 = 0 = Serial Data Input Over-run
D4 = Serial Input PAD SID Pad
D3 = 0 = Shift Key Depressed
D2 = 0 = Last Key is Still Depressed
D1 = 0 = Serial Input Shift Register Busy
D0 = 1 Not Used (Logic True)

D5 to D7 latches must be reset to 1 by SKRES.

(D5 and D6 are set to zero when new data and same bit of IRQST is zero.)

SKRES (Reset above Status Register) (0A): This write address resets bits 7, 6, and 5 of the Serial Port-Keyboard Status Register to 1.

not used

SERIN (Serial Input Data)(0D): This address reads the 8 bit parallel holding register that is loaded when a full byte of serial input data has been received. This address is usually read in response to a serial data in interrupt (IRQ and bit 5 of IRQST). Also see IRQEN.

D7	D6	D5	D4	D3	D2	D1	D0

SEROUT (Serial Output Data) (0D): This address writes to the 8 bit parallel holding register that is transferred to the output serial shift register when a full byte of serial output data has been transmitted. This address is usually written in response to a serial data out interrupt (IRQ and bit 4 of IRQST).

D7	D6	D5	D4	D3	D2	D1	D0

8.) IRQ INTERRUPTS: There are separate IRQ interrupt enable bits for each IRQ interrupt function (bits 0 through 7 of IRQEN). These bits are not initialized by power turn on, and must be initialized by the program before enabling the processor IRQ. The 8 types of IRQ interrupts are:

- D7 = BREAK KEY (depression of the break key)
- D6 = OTHER KEY (depression of any other key)
- D5 = SERIAL INPUT READY (Byte of serial data has been received and is ready to be read by the processor in SERIN register).
- D4 = SERIAL OUTPUT NEEDED (Byte of serial data is being transmitted and SEROUT is ready to be written to again by the processor).
- D3 = TRANSMISSION FINISHED (serial data transmission is finished. Output shift register is empty).
- D2 = TIMER # 4 (audio divider # 4 has counted down to zero)
- D1 = TIMER # 2 (audio divider # 2 has counted down to zero)
- D0 = TIMER # 1 (audio divider # 1 has counted down to zero)

These bits are enabled by bits 0 through 7 of IRQEN and identified by status bits 0 through 7 of IRQST.

The IRQEN register, like the NMIEN register, enables interrupts when its bits are 1 (logic true). The IRQST however (unlike the NMIST) has interrupt status bits that are normally logic true, and go to zero to indicate an interrupt request. The IRQST status bits are returned to logic true only by writing a zero into the corresponding IRQEN bit. This will disable the interrupt and simultaneously set the interrupt status bit to one. Bit 3 of IRQST is not a latch and does not get reset by interrupt disable. It is zero when the serial out is empty (out finished) and true when it is not.

IRQST (IRQ Interrupt Status) (0E): This address reads the data from the IRQ Interrupt Status Register.

0 = Interrupt

1 = No Interrupt

D7	D6	D5	D4	D3	D2	D1	D0

D7 = 0 Break Key Interrupt

D6 = 0 Other Key Interrupt

D5 = 0 Serial Input Data Ready Interrupt

D4 = 0 Serial Output Data Needed Interrupt

D3 = 0 Serial Output (Byte) Transmission Finished Interrupt *

D2 = 0 Timer 4 Interrupt

D1 = 0 Timer 2 Interrupt

D0 = 0 Timer 1 Interrupt

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* - NOTE: Used for generation of 2 stop bits.

IRQEN (IRQ Interrupt Enable) (0E): This address writes data to the IRQ Interrupt Enable bits.

0 = disable, corresponding IRQST bit is set to 1

1 = enable

D7	D6	D5	D4	D3	D2	D1	D0

D7 Break Key Interrupt Enable

D6 Other Key Interrupt Enable

D5 Serial Input Data Ready Interrupt Enable

D4 Serial Output Data Needed Interrupt Enable

D3 Serial Out Transmission Finished Interrupt Enable

D2 Timer 4 Interrupt Enable
D1 Timer 2 Interrupt Enable
D0 Timer 1 Interrupt Enable

9. ELECTRICAL PARAMETERS

A. General:

1.1 Storage Temperature..-40°C to +90°C

1.2 Ambient operating temperature.................................0°C to +70°C

1.3 Failure rate less than 0.1% per 1000 hours

1.4 Maximum voltage range on any pin with respect to VSS (Pin 1: substrate) without permanent damage to the chip..-0.5V to +9.0V

B. D.C. and Operating Characteristics:

All voltages are referenced to VSS (pin 1). TA= 0°C to 70°C.

	MIN.	TYP.	MAX.	UNIT
VCC (PIN 17)	+4.75		+5.25	VOLTS
ICC (PIN 17)			125.0	mA
NORMAL INPUTS:				
SID (PIN 24), $\overline{CS0}$ (PIN 30), CS1 (PIN 31), A0-A3 (PIN 36-PIN 33), R/W (PIN 32), $\overline{KR1}$ (PIN 25), $\overline{KR2}$ (PIN 16)				
V_{IH} INPUT HIGH VOLTAGE:	2.0		VCC	VOLTS
V_{IL} INPUT LOW VOLTAGE:	-0.5		+0.8	VOLTS
$I_{LEAKAGE}$ INPUT LEAKAGE: VIN=7.0 VOLTS			10.0	uA
C_{PIN} PIN CAPACITANCE			7.0	pf
DATA BUS I/O:				
D0-D2 (PIN 38-PIN 40), D3-D7 (PIN 2-PIN 6)				
INPUT:				
V_{IH} INPUT HIGH VOLTAGE:	2.0		VCC	VOLTS
V_{IL} INPUT LOW VOLTAGE:	-0.5		+0.8	VOLTS
$I_{LEAKAGE}$ INPUT LEAKAGE: OUTPUT TRI-STATED VIN=+7.0 VOLTS			10.0	uA
C_{PIN} PIN CAPACITANCE			15.0	pf
OUTPUT:				
V_{OH} OUTPUT HIGH VOLTAGE: I LOAD=-0.1mA	2.4			VOLTS
V_{OL} OUTPUT LOW VOLTAGE: I LOAD=+1.6mA			0.4	VOLTS
C_{LOAD} LOAD CAPACITANCE			130.0	pf

B.) D.C. and Operating Characteristics: (Continued)

B) D.C. AND OPERATING CHARACTERISTICS: (CONT.)

	MIN.	TYP.	MAX.	UNIT
BI-DIRECTIONAL I/O (SCHMITT TRIGGER INPUT): BCLK (PIN 26), P0 (PIN 14), P1 (PIN 15), P2 (PIN 12), P3 (PIN 13), P4 (PIN 10), P5 (PIN 11), P6 (PIN 8), P7 (PIN 9)				
INPUT:				
V_{T+} POSITIVE-GOING THRESHOLD VOLTAGE:	1.9		2.6	VOLTS
V_{T-} NEGATIVE-GOING THRESHOLD VOLTAGE:	1.0		2.1	VOLTS
V_{HYS} HYSTERESIS:	0.3			VOLTS
$I_{LEAKAGE}$ INPUT LEAKAGE: VIN=7.0 VOLTS PULL-DOWN IS TURNED OFF			10.0	uA
C_{PIN} PIN CAPACITANCE			7.0	pf
OUTPUT:				
V_{OL} OUTPUT LOW VOLTAGE: I LOAD=+1.6mA			0.4	VOLTS
C_{LOAD} LOAD CAPACITANCE			30.0	pf
OUTPUT (OPEN DRAIN ONLY):				
$\overline{IRQ}$ (PIN 29), SOD (PIN 28), OCLK (PIN 27)				
V_{OL} OUTPUT LOW VOLTAGE: I LOAD=+1.6mA			0.4	VOLTS
$I_{LEAKAGE}$ INPUT LEAKAGE: VIN=7.0 VOLTS PULL-DOWN IS TURNED OFF			10.0	uA
C_{LOAD} LOAD CAPACITANCE			30.0	pf
INPUT CLOCK :				
B2 (PIN 7)				
V_{IH} INPUT HIGH VOLTAGE:	2.0		VCC	VOLTS
V_{IL} INPUT LOW VOLTAGE:	-0.5		+0.8	VOLTS
$I_{LEAKAGE}$ INPUT LEAKAGE: VIN=7.0 VOLTS			10.0	uA
C_{PIN} PIN CAPACITANCE			14.0	pf
KEYBOARD SCAN OUTPUT:				
$\overline{K0}$-$\overline{K5}$ (PIN 23-PIN 18)				
V_{OH} OUTPUT HIGH VOLTAGE: I LOAD=-100.0 uA	2.4			VOLTS
V_{OH} OUTPUT HIGH VOLTAGE: I LOAD=-0.0 uA	4.3			VOLTS
V_{OL} OUTPUT LOW VOLTAGE: I LOAD=+1.6mA			0.4	VOLTS
C_{LOAD} LOAD CAPACITANCE			30.0	pf

D.C. and Operating Characteristics: (Continued)

	MIN.	TYP.	MAX.	UNIT
AUDIO OUTPUT (MULTIPLE OPEN DRAIN OUTPUT):				
AUD (PIN 37)				
V_{OL} OUTPUT LOW VOLTAGE: WITH 10K ± 5% OHM PULL UP TO 4.75 Vdc.				
10 micron / 10 micron DEVICE ON ONLY.			4.2	VOLT
20 micron / 10 micron DEVICE ON ONLY.			3.4	VOLT
40 micron / 10 micron DEVICE ON ONLY.			2.1	VOLT
80 micron / 10 micron DEVICE ON ONLY.			1.2	VOLT
V_{OH} OUTPUT HIGH VOLTAGE: WITH 10K ± 5% OHM PULL UP TO 4.75Vdc AND ALL FOUR DEVICES OFF	4.2			VOLT
C_{LOAD} LOAD CAPACITANCE			30.0	pf

C.) Dynamic Operating Characteristics:

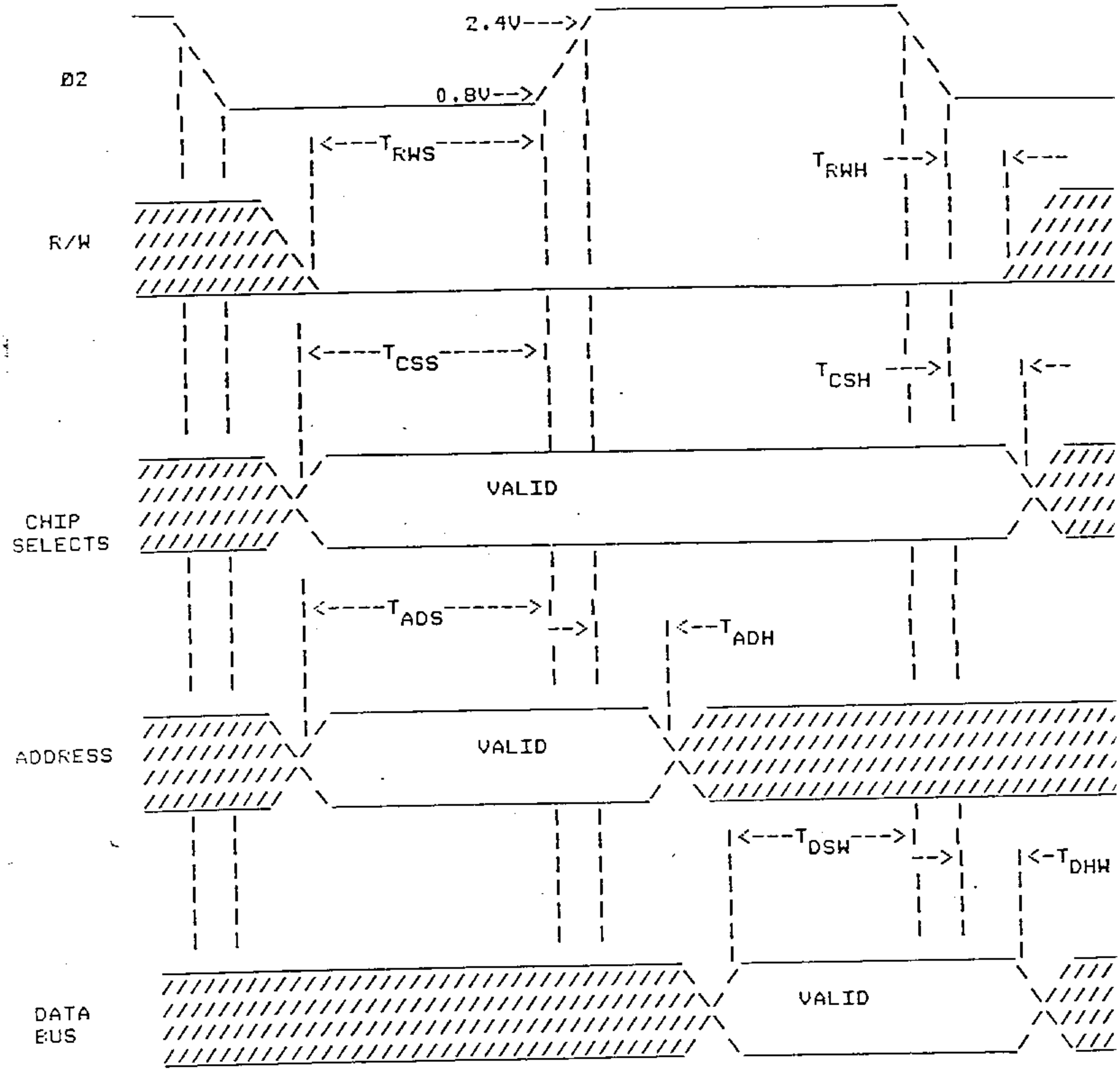
(VDD = 5V±5% TA = 0° to 70°C)

Parameter	Note	Signal Type	Symbol	MIN.	MAX.	UNI
INPUT TIMING:						
R/W SETUP TIME		BLE	T_{RWS}	130		nS
R/W HOLD TIME		ATE	T_{RWH}	30		nS
ADDRESS SETUP TIME		BLE	T_{ADS}	130		nS
ADDRESS HOLD TIME		ALE	T_{ADH}	30		nS
CHIP SELECT SETUP TIME		BLE	T_{CSS}	50		nS
CHIP SELECT HOLD TIME		ATE	T_{CSH}	30		nS
DATA SETUP TIME : D0-D7		BTE	T_{DSW}	130		nS
DATA HOLD TIME : D0-D7		ATE	T_{DHW}	10		nS
DATA SETUP TIME : $\overline{KR1}$,$\overline{KR2}$, P0-P7,SID,BCLK		BTE	T_{DS}	150		nS
OUTPUT TIMING:						
DATA SETUP TIME : D0-D7	2	BTE	T_{DSR}	50		nS
DATA HOLD TIME : D0-D7	2	ATE	T_{DHR}	20		nS
DATA DELAY TIME : $\overline{IRQ}$	1	ALE	T_{DD}		350	nS
DATA DELAY TIME :SOD,BCLK, OCLK	1	ATE	T_{DD}		350	nS
DATA DELAY TIME : AUD	3	ATE	T_{DD}		200	nS
DATA DELAY TIME : $\overline{K0-K5}$	1	ATE	T_{DD}		1.5	uS
DATA DELAY TIME : P0-P7	1	ALE	T_{DD}		1.5	uS

NOTES:

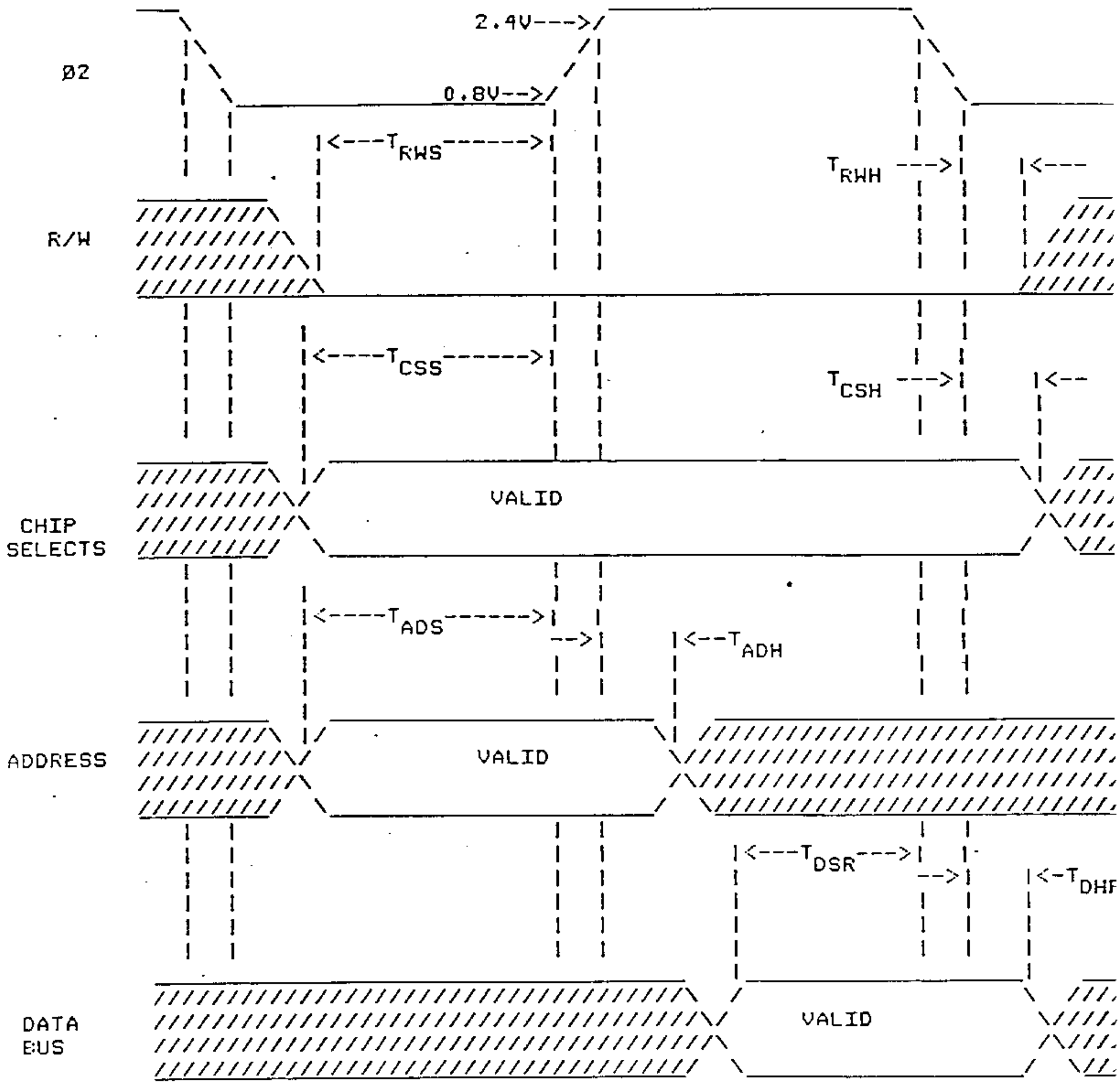
1) OUTPUT LOAD AT 30pF + 1 TTL
2) OUTPUT LOAD AT 130pF + 1 TTL
3) OUTPUT LOAD AT 30pF

D.) Write I/O Timing:



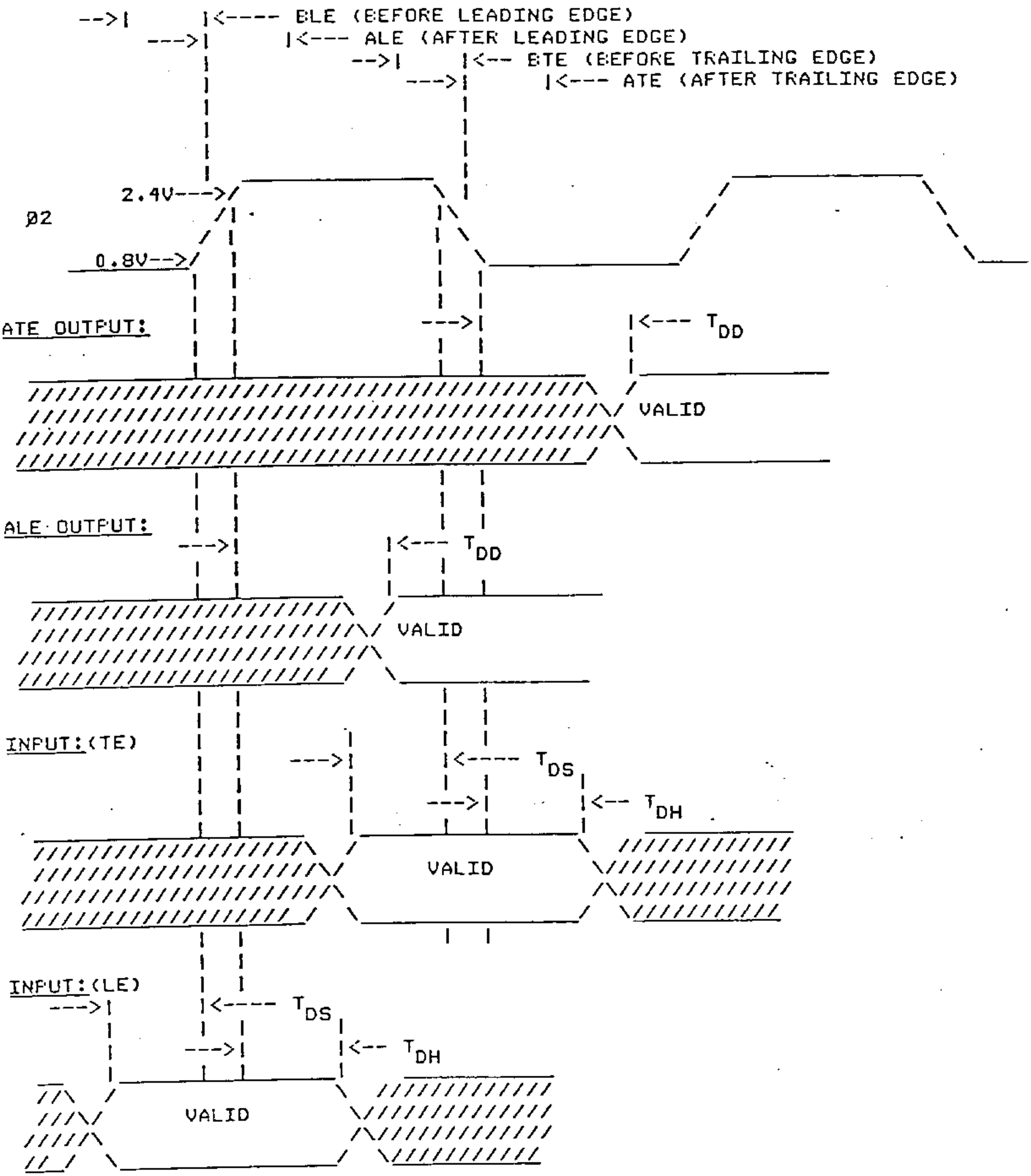
NOTE: ADDRESSES ARE CLOCKED IN ON THE RAISING EDGE OF Ø2.

E.) Read I/O Timing:



NOTE: ADDRESSES ARE CLOCKED IN ON THE RAISING EDGE OF Ø2.

F. I/O Timing:



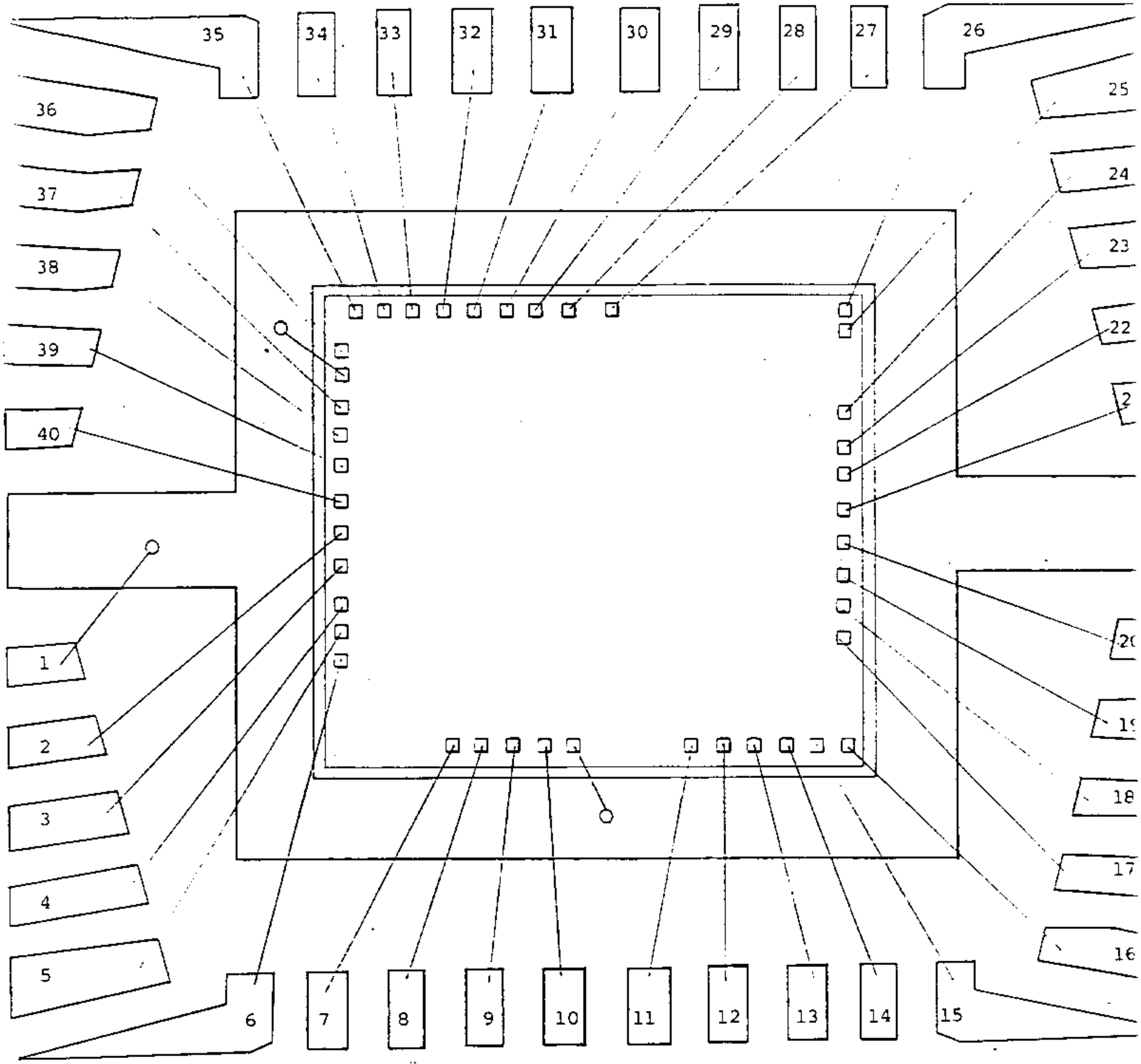
--->| |<---- BLE (BEFORE LEADING EDGE)
--->| |<--- ALE (AFTER LEADING EDGE)
-->| |<-- BTE (BEFORE TRAILING EDGE)
--->| |<--- ATE (AFTER TRAILING EDGE)
2.4V--->
Ø2
0.8V-->
ATE OUTPUT:
--->|
|<--- T DD
VALID
ALE OUTPUT:
--->|
|<--- T DD
VALID
INPUT:(TE)
--->|
|<---- T DS
--->|
|<-- T DH
VALID
INPUT:(LE)
--->|
|<---- T DS
--->|
|<-- T DH
VALID

POKEY ADDRESS TABLE:

ADDRESS	WRITE		READ	
	Name	Description	Name	Description
0	AUDF1	Audio Channel 1 Frequency	POT0	Read the value of each pot
1	AUDC1	Audio Channel 1 Control	POT1	
2	AUDF2	Audio Channel 2 Frequency	POT2	
3	AUDC2	Audio Channel 2 Control	POT3	
4	AUDF3	Audio Channel 3 Frequency	POT4	
5	AUDC3	Audio Channel 3 Control	POT5	
6	AUDF4	Audio Channel 4 Frequency	POT6	
7	AUDC4	Audio Channel 4 Control	POT7	
8	AUDCTL	Audio Control	ALLPOT	Read 8 line pot port state
9	STIMER	Start timers	KBCODE	Keyboard code
A	SKRES	Reset Status (SKSTAT)	RANDOM	Random number generator
B	POTGO	Start pot scan sequence		
C				
D	SEROUT	Serial port output register	SERIN	Serial port input register
E	IRQEN	IRQ Interrupt enable	IRQST	IRQ Interrupt status register
F	SKCTLS	Serial port 4 key control	SKSTAT	Serial port 4 key status register

POKEY PIN LIST:

PACKAGE PIN	NAME	FUNCTION	
1	VSS	Ground	I
2	D3	Data Bus	I/O
3	D4	Data Bus	I/O
4	D5	Data Bus	I/O
5	D6	Data Bus	I/O
6	D7	Data Bus	I/O
7	O2	Phase 2 Clock	I
8	P6	Pot Scan	I
9	P7	Pot Scan	I
10	P4	Pot Scan	I
11	P5	Pot Scan	I
12	P2	Pot Scan	I
13	P3	Pot Scan	I
14	P0	Pot Scan	I
15	P1	Pot Scan	I
16	/KR2	Keyboard Scan	I
17	VDD	5 V Power	I
18	/K5	Keyboard Scan	O
19	/K4	Keyboard Scan	O
20	/K3	Keyboard Scan	O
21	/K2	Keyboard Scan	O
22	/K1	Keyboard Scan	O
23	/K0	Keyboard Scan	O
24	SID	Serial Input Data	I
25	/KR1	Keyboard Scan	I
26	BCLK	Bidirection Clock	I/O
27	OCLK	Serial Output Clock	O
28	SOD	Serial Output Data	O
29	/IRQ	Interrupt Request	O
30	/CS0	Chip Select	I
31	CS1	Chip Select	I
32	R/W	Read/Write Control	I
33	A3	Address Bus	I
34	A2	Address Bus	I
35	A1	Address Bus	I
36	A0	Address Bus	I
37	AUDIO	Audio Out	O
38	D0	Data Bus	I/O
39	D1	Data Bus	I/O
40	D2	Data Bus	I/O



SCALE: 20:1
PACKAGE 204,000-3
DIE SIZE: 179 mils X 159 mils
WIRE BOND: 1.1 mil gold T.C.
DIE ATTACH CAVITY: 210 X 230

COMMENT :
Six Micron Design Rules.

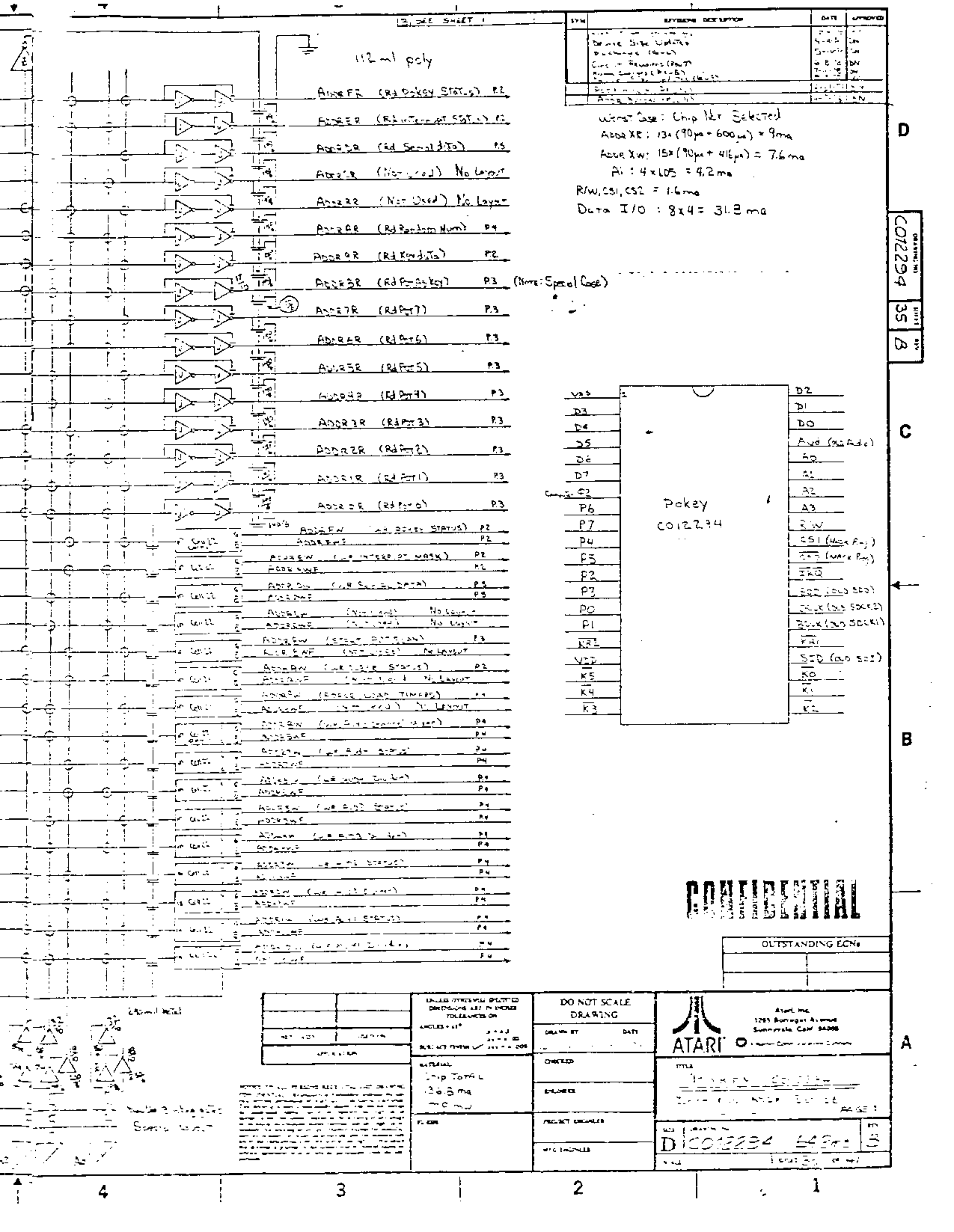
POKEY BONDING DIAGRAM
(Figure 11)

SYM	REVISIONS	DATE	APPROVED
B	SEE SHEET 1		

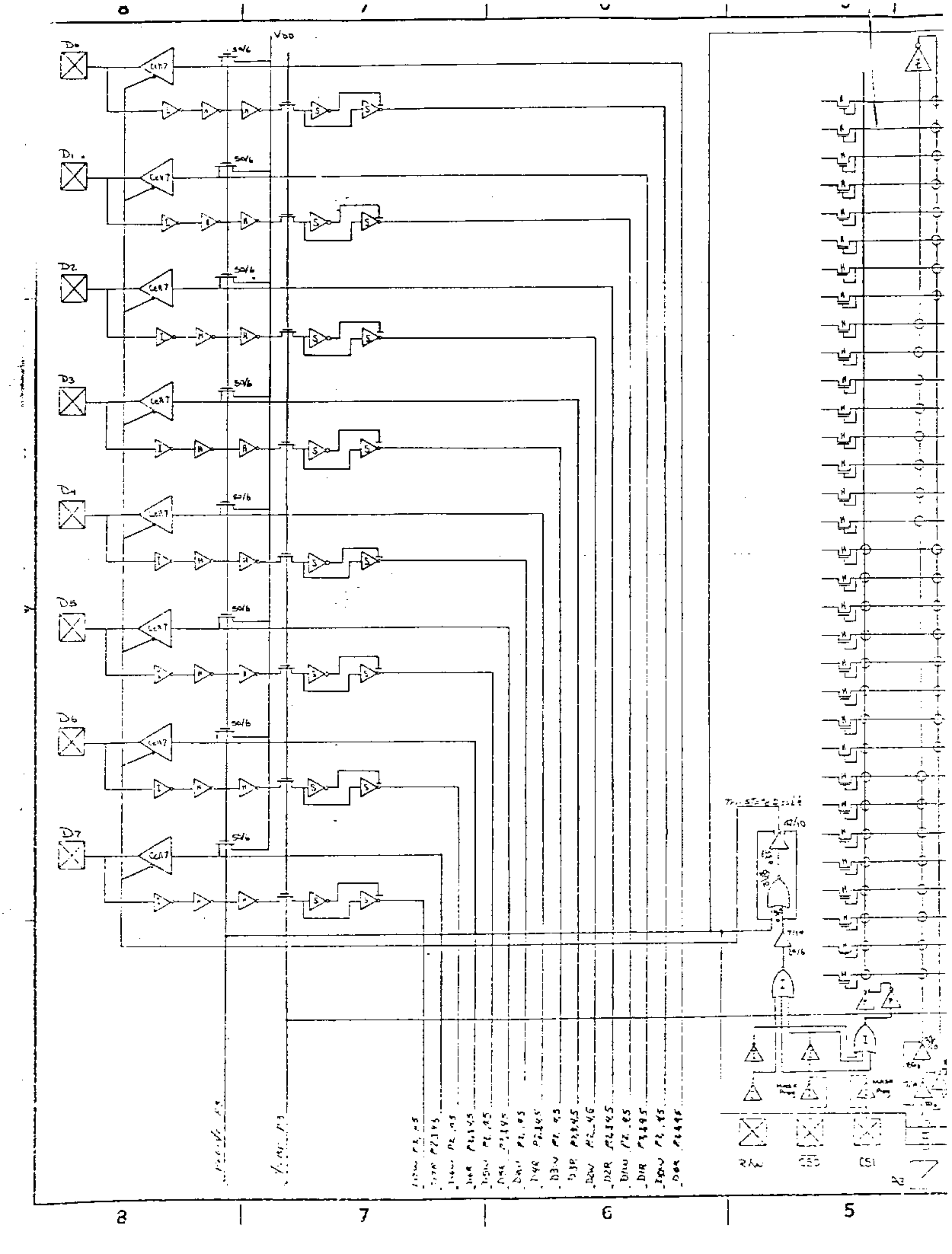
ATARI

POKEY CHIP

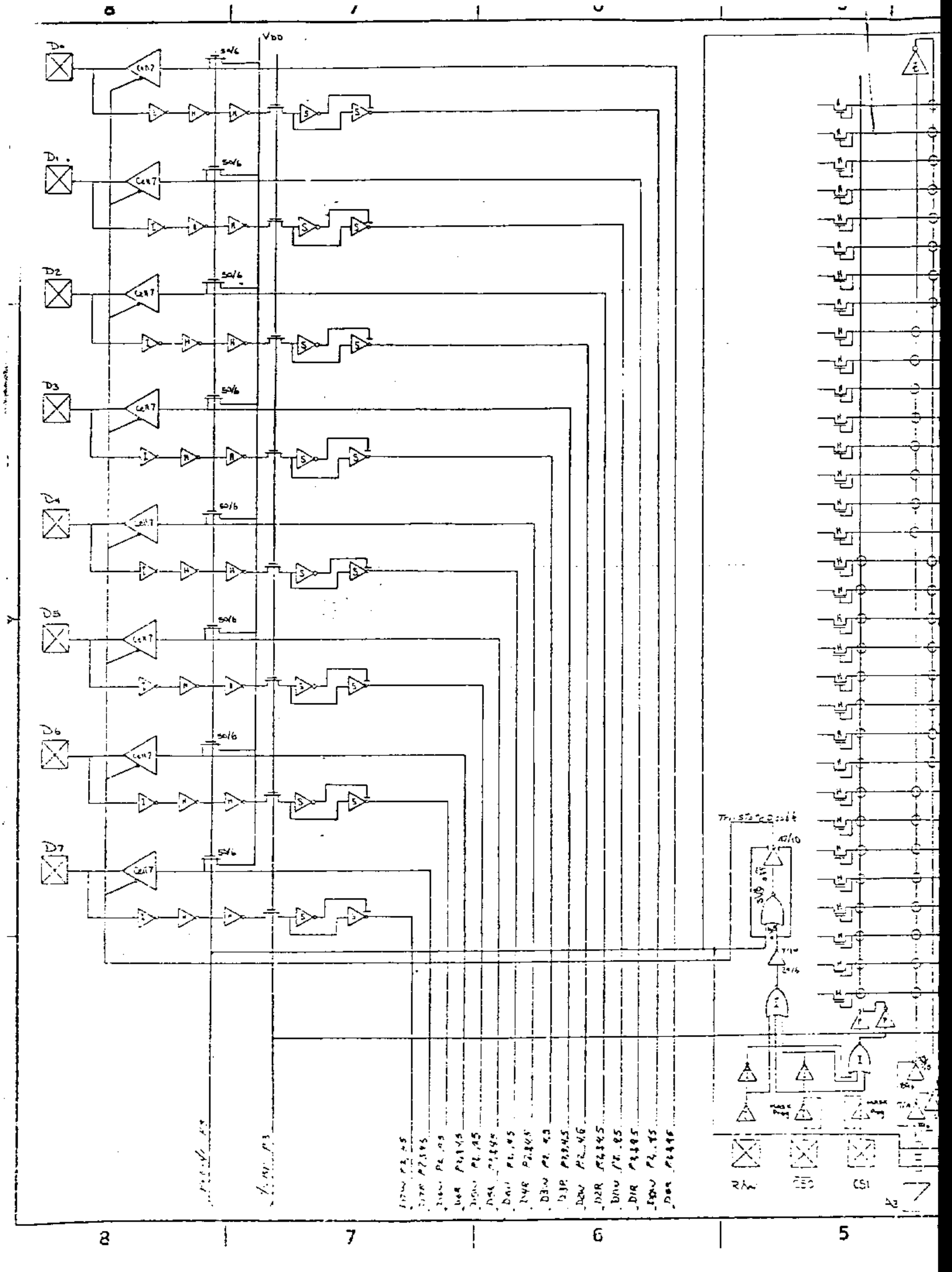
DRAWN BY	ENGINEERG. MGR.	MATERIAL
CHECKED	QUAL. ASSURANCE	DRAWING NO
ENGINEER	MFG ENGINEERG	C012994



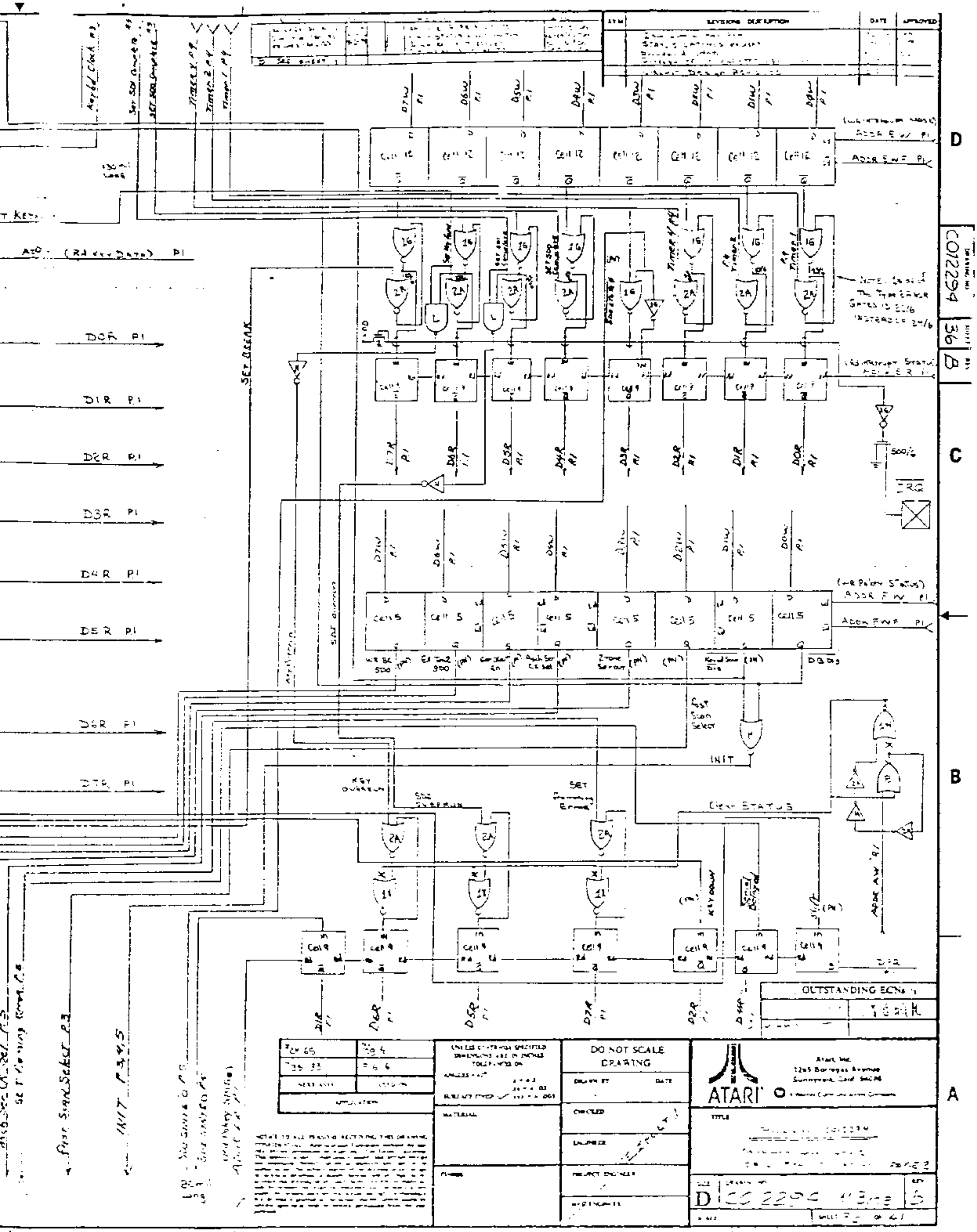
112 mil poly
Worst Case: Chip Not Selected
Addr XR: 13x(90μa + 600μa) = 9ma
Addr Xw: 15x(90μa + 416μa) = 7.6ma
Ai: 4 x L05 = 4.2ma
R/W, CS1, CS2 = 1.6ma
Data I/O : 8x4 = 31.8 ma
ADDR FR (Rd Pokey Status) P2
ADDR ER (Rd Interrupt Status) P2
ADDR DR (Rd Serial Data) P5
(Not Used) No Layout
ADDR 2R (Not Used) No Layout
ADDR AR (Rd Random Num) P4
ADDR 9R (Rd Kbd Data) P2
ADDR 8R (Rd Pot Ackey) P3 (Note: Special Case)
ADDR 7R (Rd Pot 7) P3
ADDR 6R (Rd Pot 6) P3
ADDR 5R (Rd Pot 5) P3
ADDR 4R (Rd Pot 4) P3
ADDR 3R (Rd Pot 3) P3
ADDR 2R (Rd Pot 2) P3
ADDR 1R (Rd Pot 1) P3
ADDR 0R (Rd Pot 0) P3
Pokey
C012294
VSS
D3
D4
D5
D6
D7
P6
P7
P4
P5
P2
P3
P0
P1
VDD
K5
K4
K3
D2
D1
D0
A0
A1
A2
A3
R/W
CS1
IRQ
KR1
SID
K0
K1
K2
CONFIDENTIAL
OUTSTANDING ECNs
DO NOT SCALE DRAWING
DRAWN BY
DATE
CHECKED
ENGINEER
PROJECT ENGINEER
MFG ENGINEER
MATERIAL
Chip Total
FINISH
ATARI
Atari, Inc.
1265 Borregas Avenue
Sunnyvale, Calif. 94086
TITLE
SIZE
D
C012294
C012294
35
B
A
B
C
D
4
3
2
1



D0
D1
D2
D3
D4
D5
D6
D7
VDD
50/6
CeR7
TRI-STATE
R/W
CS1
8
7
6
5



D0
D1
D2
D3
D4
D5
D6
D7
VDD
50/6
TRI-STATE CONTROL
R/W
CS0
CS1
8
7
6
5



REVISIONS DESCRIPTION
DATE
APPROVED
D
C
B
A
4
3
2
1
C012294
36
B
D0R P1
D1R P1
D2R P1
D3R P1
D4R P1
D5R P1
D6R P1
D7R P1
SET BREAK
INIT
Clear STATUS
KEY OVERRUN
Set Overrun
OUTSTANDING ECNs
DO NOT SCALE DRAWING
DRAWN BY
DATE
CHECKED
ENGINEER
PROJECT ENGINEER
MATERIAL
FINISH
NEXT ASSY
APPLICATION
TITLE
SIZE
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DRAWING NO.
REV
SCALE
SHEET
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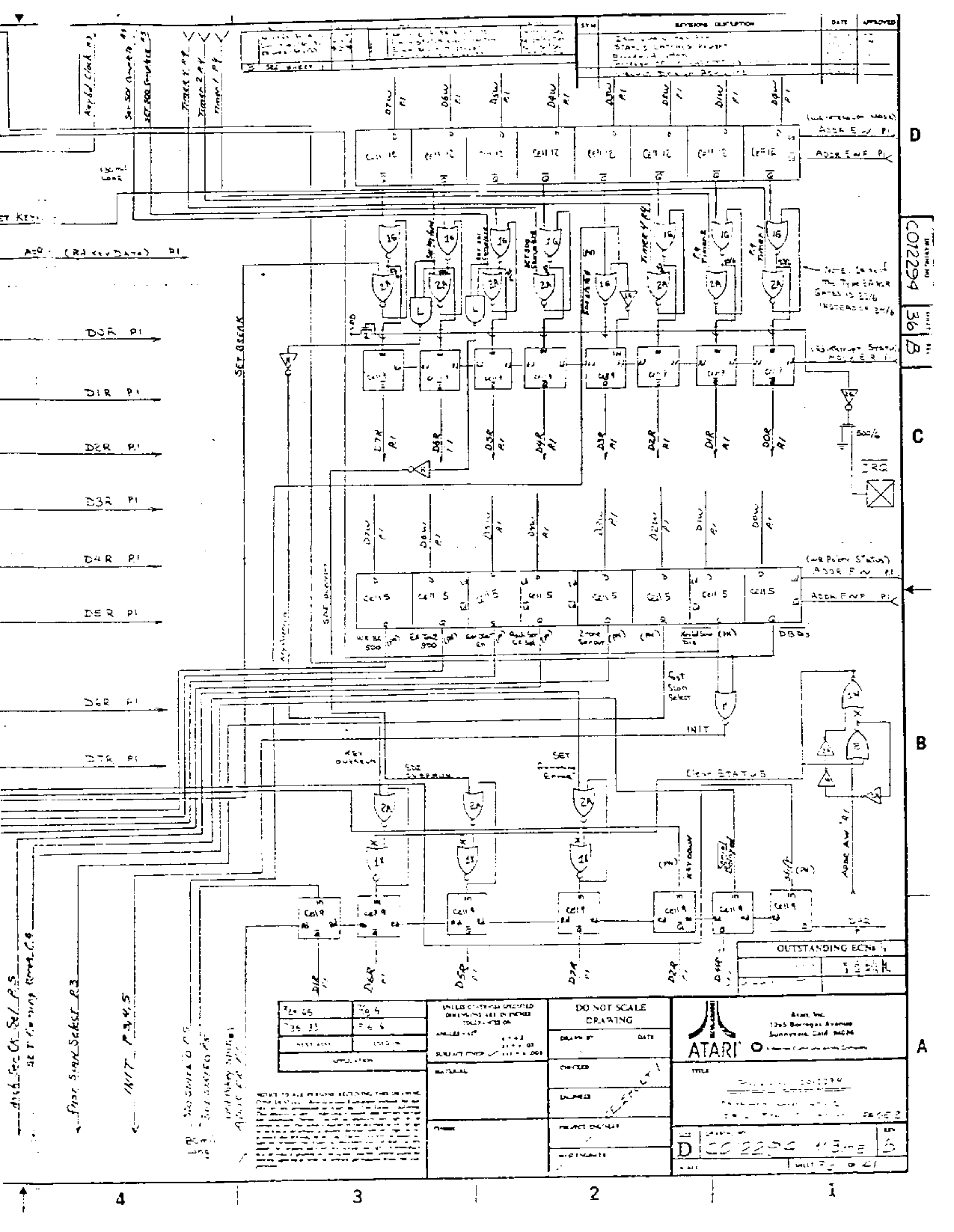

D
C
B
A
4
3
2
1
C012294
36
B
Keybd Clock P3
Timer 4 P4
Timer 2 P4
Timer 1 P4
D7W P1
D6W P1
D5W P1
D4W P1
D3W P1
D2W P1
D1W P1
D0W P1
ADDR E W P1
ADDR E W F P1
Cell 12
1G
2A
Cell 9
D0R P1
D1R P1
D2R P1
D3R P1
D4R P1
D5R P1
D6R P1
D7R P1
SET BREAK
500/6
IRQ
(W R Polny Status)
Cell 5
DBBs
INIT
Key Overrun
Set Framing Error
Clear STATUS
Fast Scan Select
Key down
Shift
ADDR AW P1
D7R
D6R
D5R
D3R
D2R
OUTSTANDING ECN's
DO NOT SCALE DRAWING
DRAWN BY
DATE
CHECKED
ENGINEER
PROJECT ENGINEER
MATERIAL
FINISH
APPLICATION
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Sunnyvale, Calif. 94086
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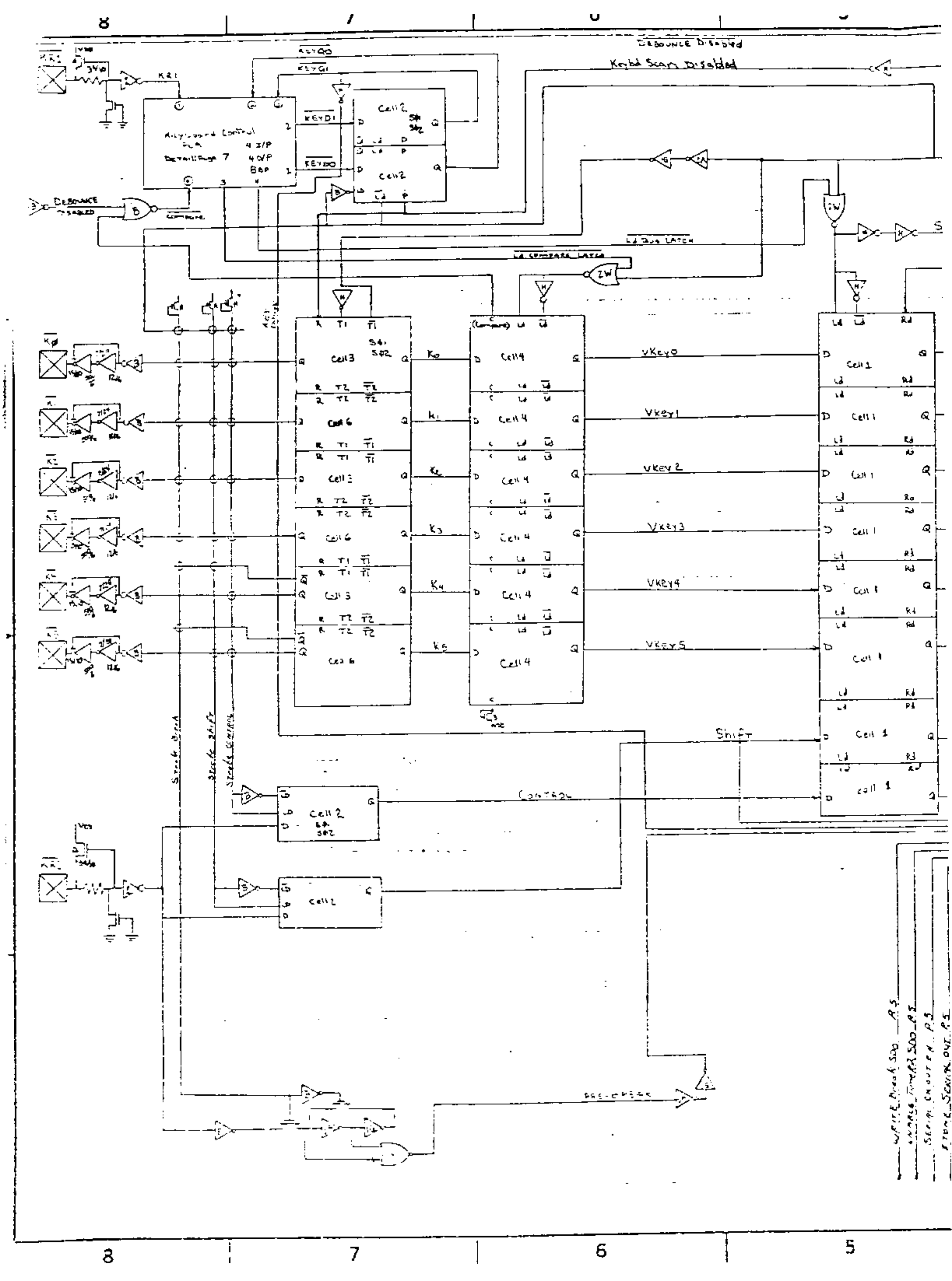
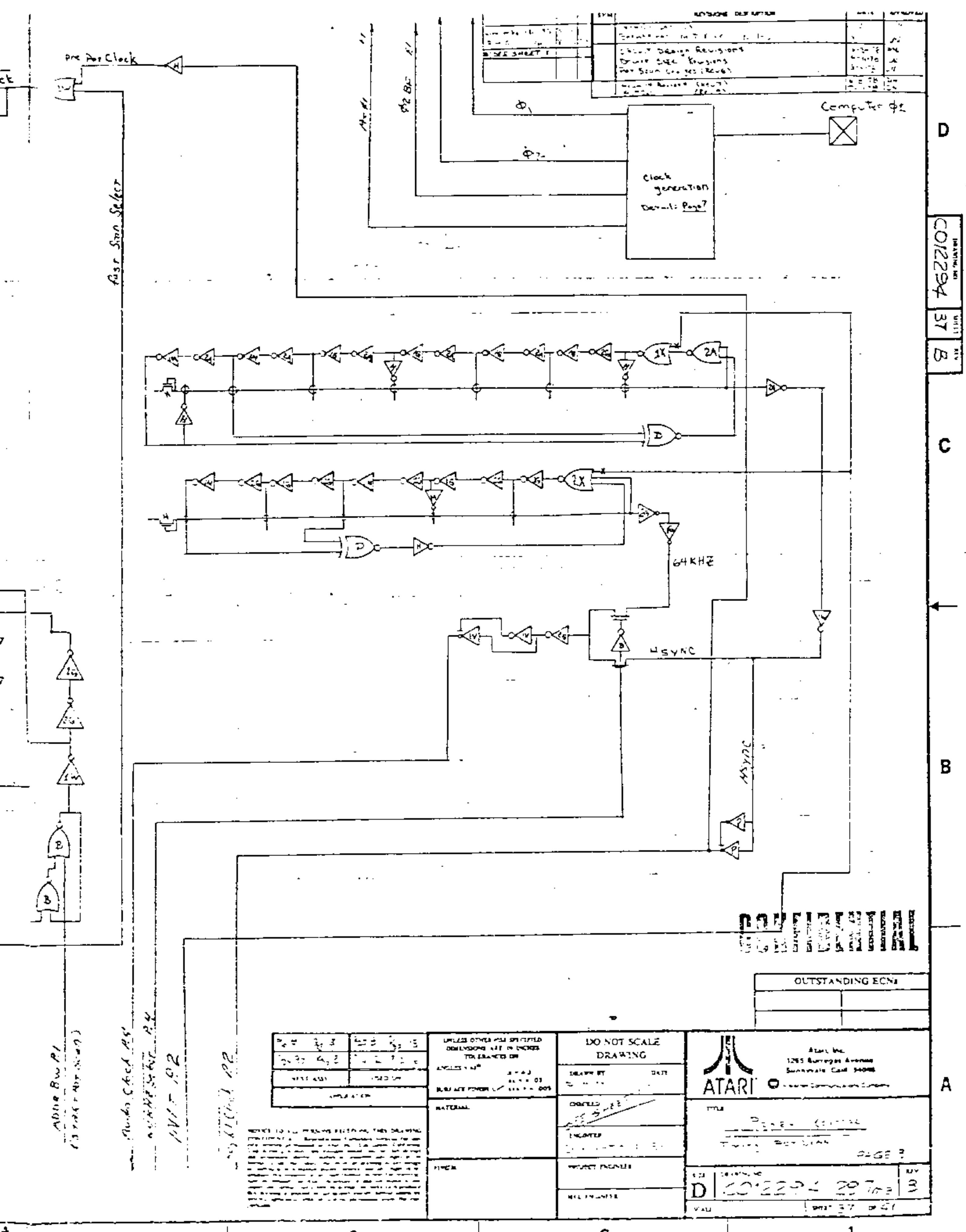
TITLE
PAGE 2
D
C012294
B
INIT P3,4,5
Fast Scan Select P3



Debounce Disabled
Keybd Scan Disabled
Keyboard Control PLA
Detail Page 7
KEYD1
KEYD0
Ld Bus Latch
Ld Compare Latch
VKey0
VKey1
VKey2
VKey3
VKey4
VKey5
Shift
Control
Pre-Break



Pre Par Clock
Φ2 BF
Φ1
Φ2
Computer Φ2
Clock generation
Detail: Page 7
C012294
37
B
D
C
B
A
64KHZ
HSYNC
HSYNC
CONFIDENTIAL
OUTSTANDING ECNs
DO NOT SCALE DRAWING
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PAGE 7
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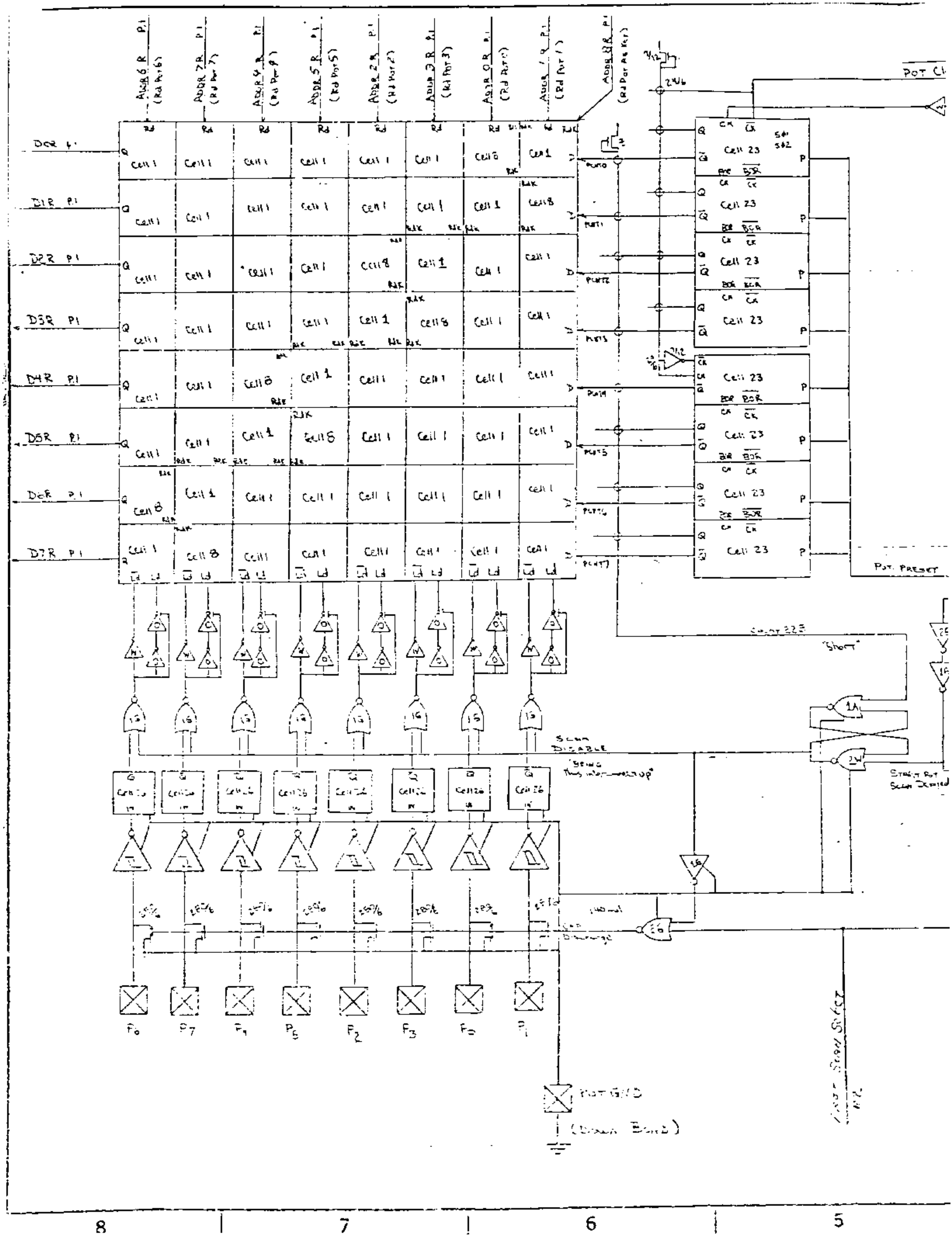
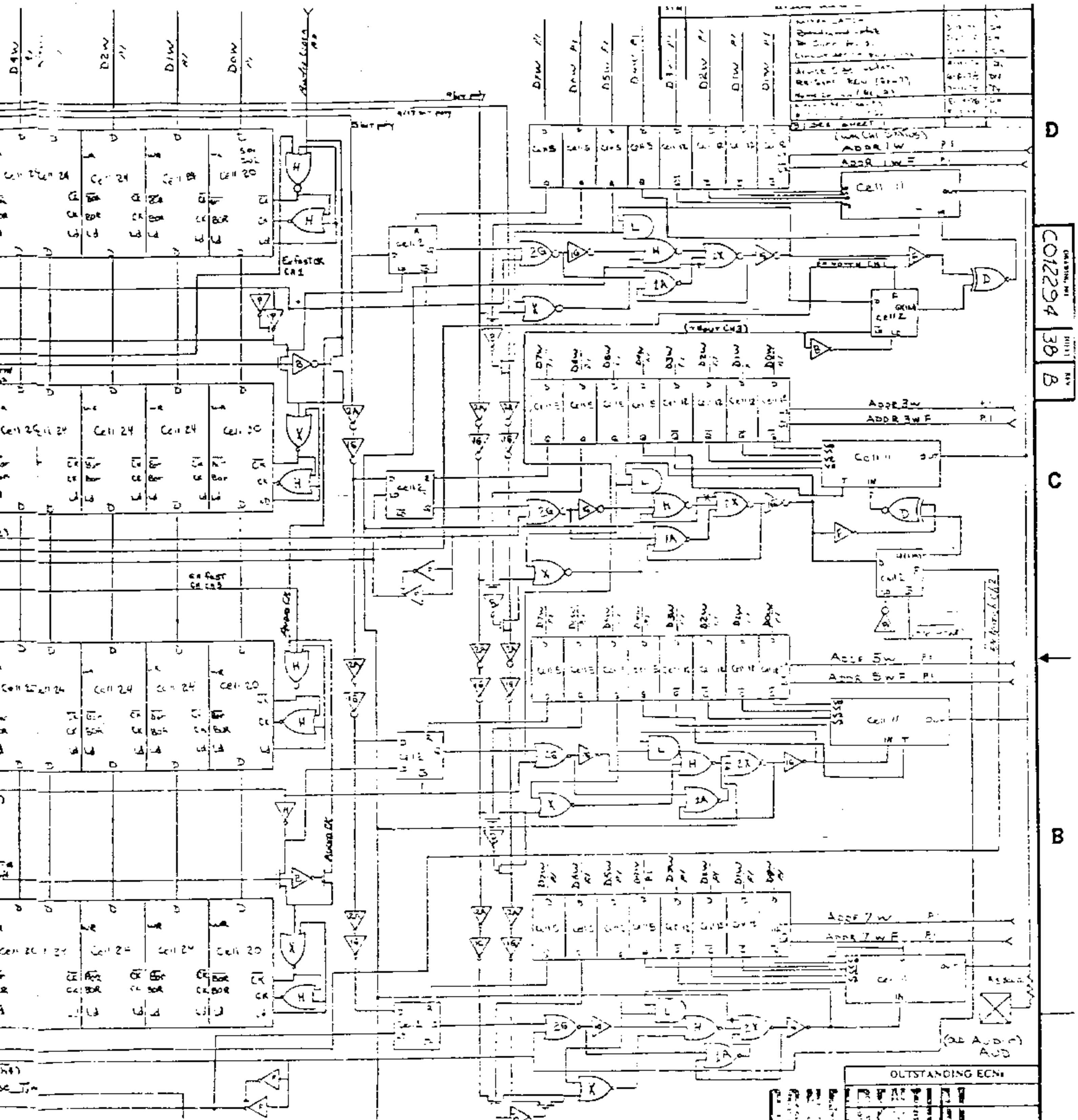
2
1



ADDR 6 R P1 (Rd Pot 6)
ADDR 7 R P1 (Rd Pot 7)
ADDR 5 R P1 (Rd Pot 5)
ADDR 2 R P1 (Rd Pot 2)
ADDR 3 R P1 (Rd Pot 3)
ADDR 0 R P1 (Rd Pot 0)
ADDR 1 R P1 (Rd Pot 1)
D1R P1
D2R P1
D3R P1
D4R P1
D5R P1
D7R P1
Cell 1
Cell 8
Cell 23
Cell 26
POT PRESET
Scan Disable
"Short"
Pot GND
8
7
6
5



OUTSTANDING ECNs

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PAGE 4

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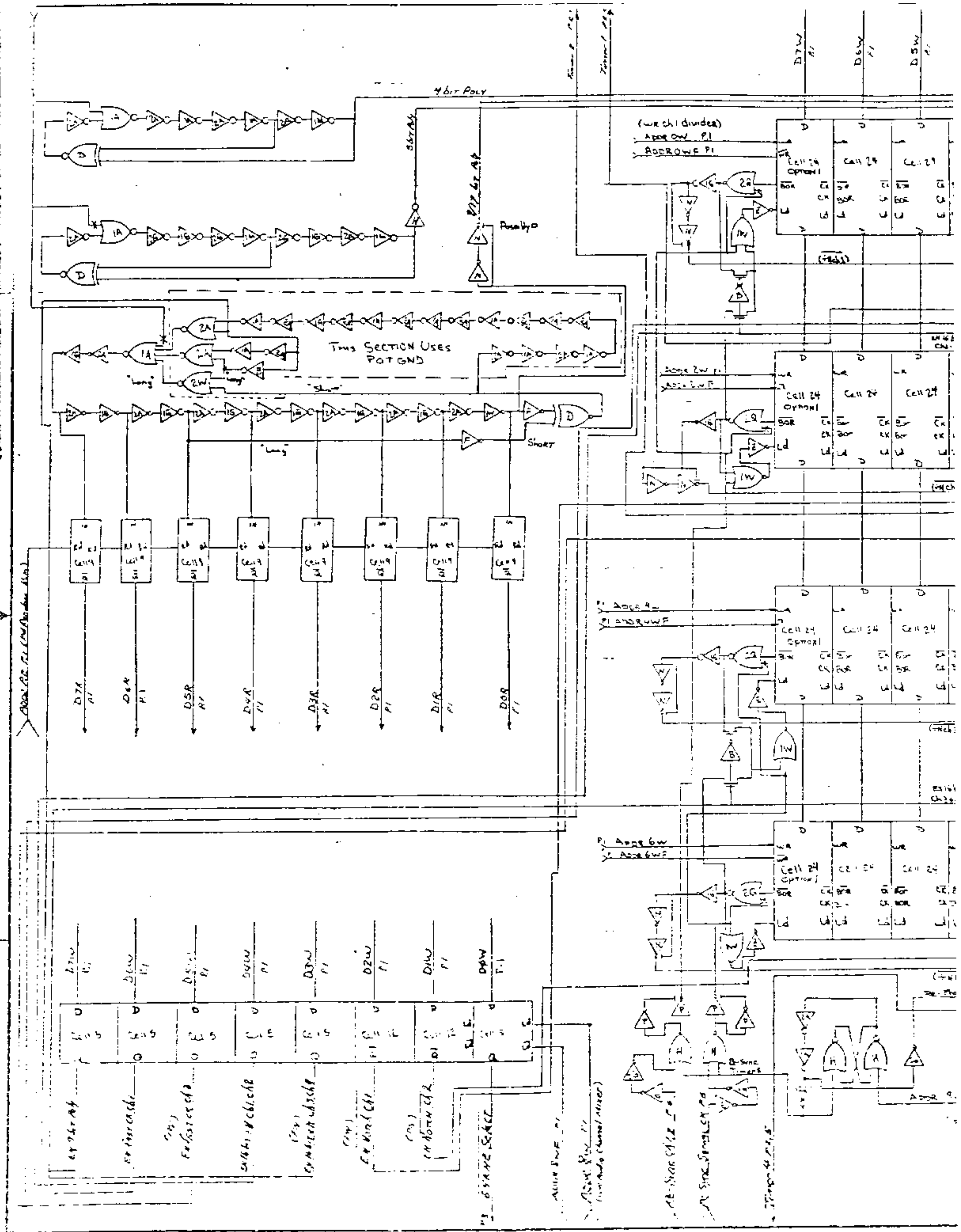
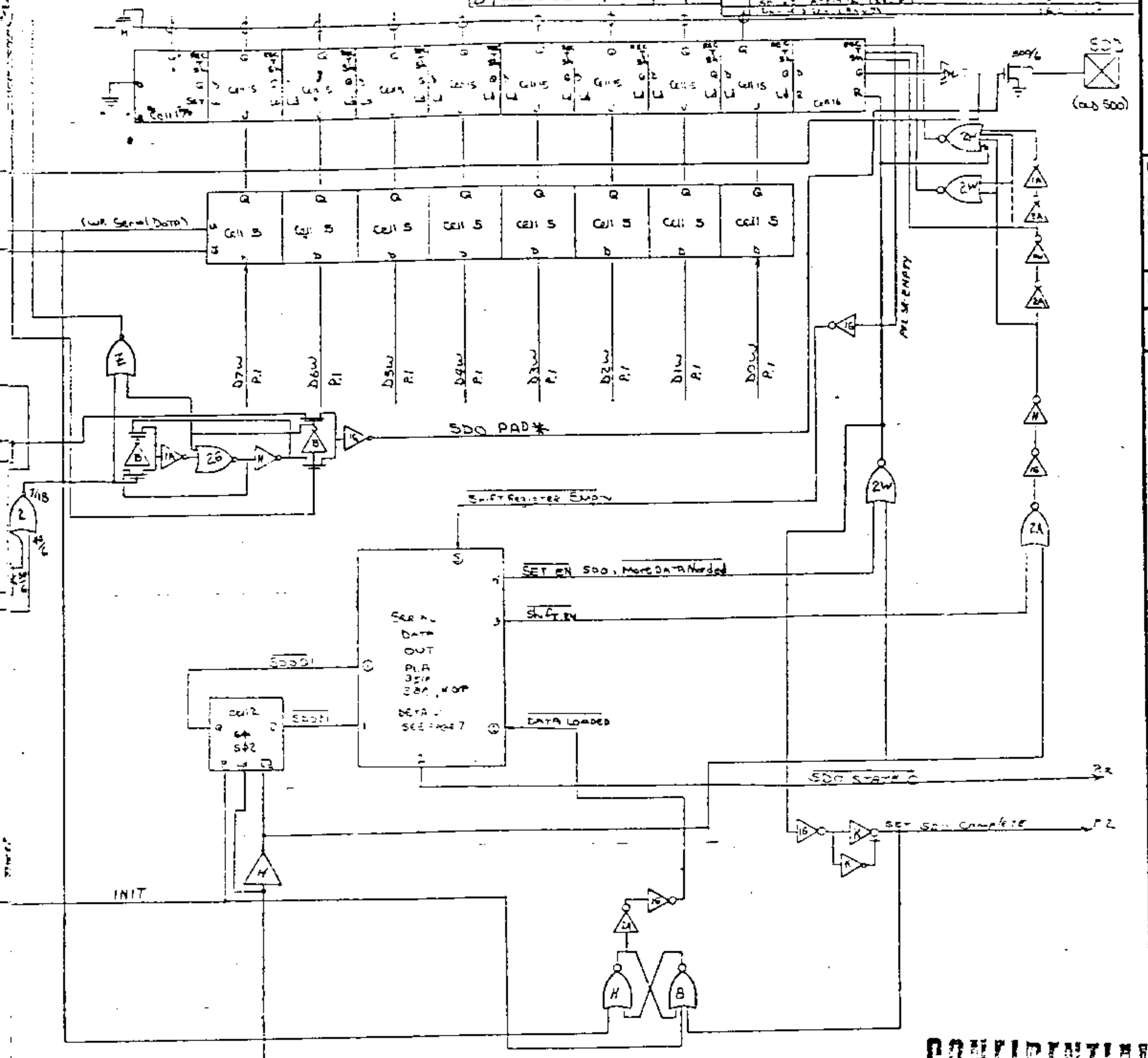
2
1


4 BIT POLY
This Section Uses POT GND
"Long"
"Short"
Short
(write ch1 divides)
ADDROWE P1
Cell 24 Option 1
Cell 24
Cell 9
Cell 5
D7R P1
D6R P1
D5R P1
D4R P1
D3R P1
D2R P1
D1R P1
D0R P1
D7W
D6W
D5W
D4W
D3W
D2W
D1W
D0W
Addr 6W
Addr 6WE
Addr 4W
P1 ADDR4WE
Addr 2W P1
B-Sync Timers
8
7
6
5



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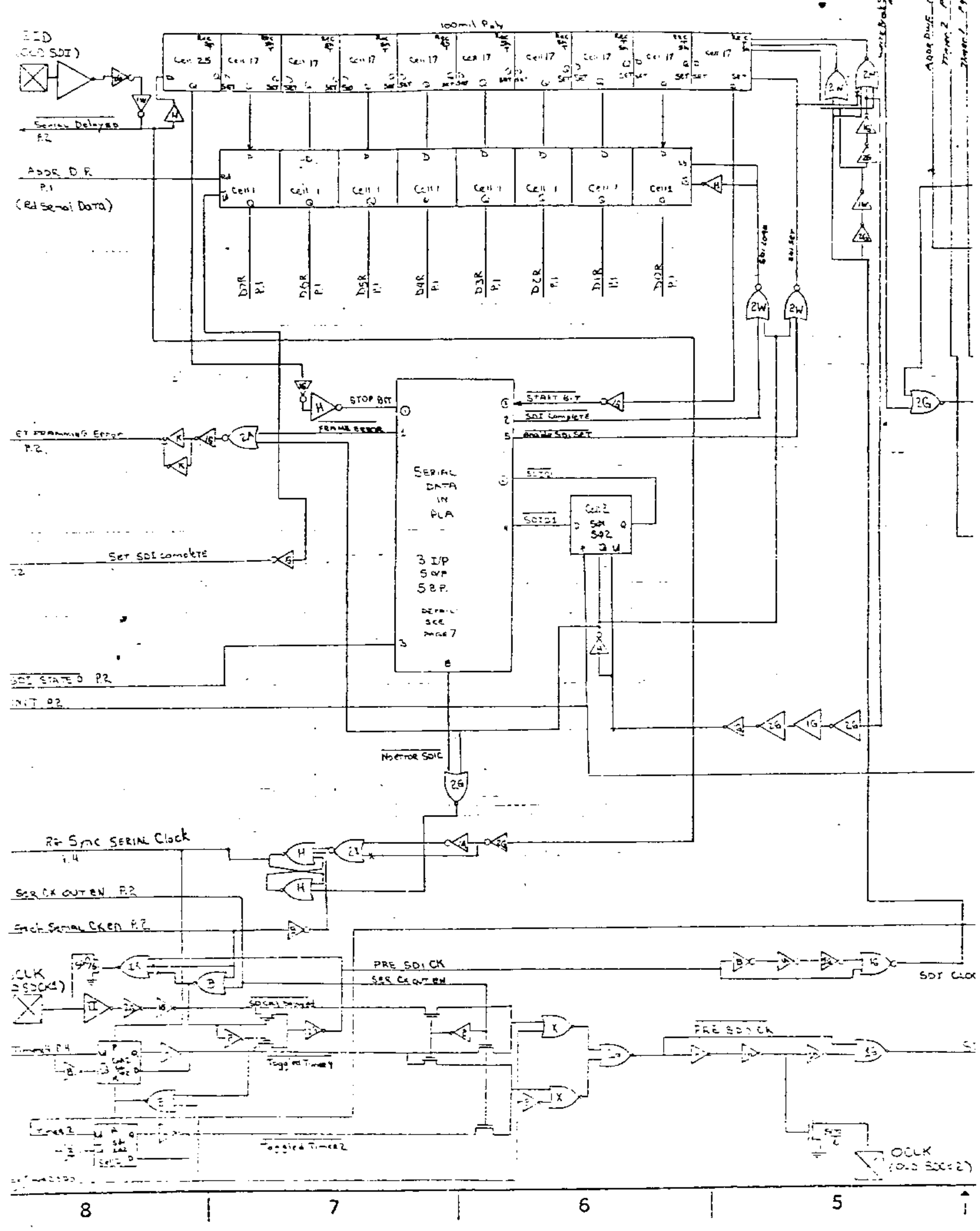
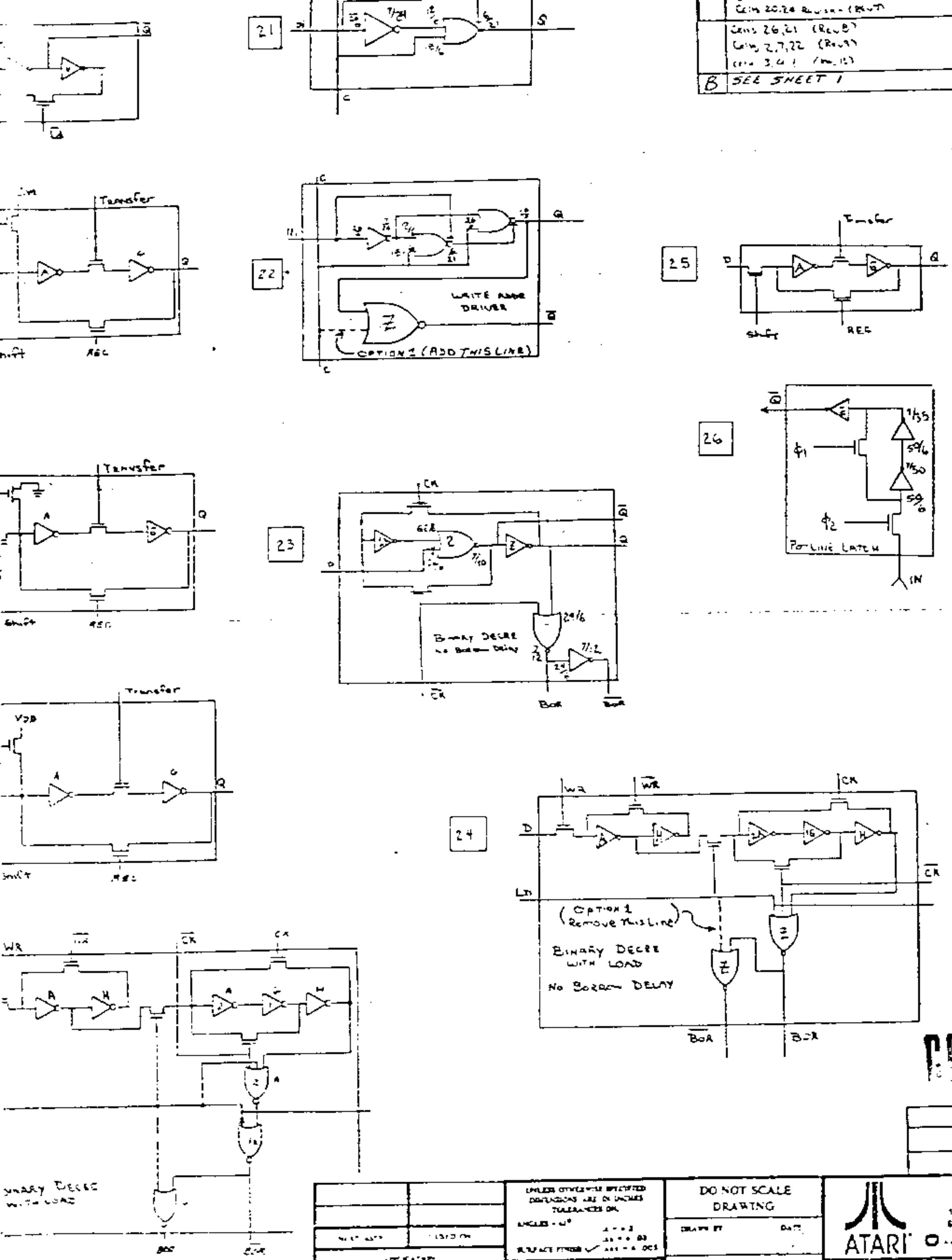
Page 5



100mil Poly
Serial Delayed
P.2
ADDR D.R.
P.1
(Rd Serial Data)
D7R
D6R
D5R
D4R
D3R
D2R
D1R
D0R
STOP BIT
START BIT
SDI Complete
FRAME ERROR
SERIAL
DATA
IN
PLA
3 I/P
5 O/P
5 S.P.
DETAIL
SEE
PAGE 7
SET SDI complete
SDI STATE 0 P.2
INIT P.2
No error SDIC
Rx Sync SERIAL Clock
SER CK OUT EN P.2
PRE SDI CK
SER CK OUT EN
SDI Clock
Toggled Timer 1
Toggled Timer 2
PRE SDI CK
OCLK
8
7
6
5

	Cells 20,24 Revised (Rev T)		
	Cells 26,21 (Rev B)		
	Cells 2,7,22 (Rev 9)		
	Cells 3,4,1 (Rev 11)		
B	SEE SHEET 1		



CONFIDENTIAL

OUTSTANDING ECNs

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON:

DO NOT SCALE DRAWING

DRAWN BY / DATE

CHECKED

ENGINEER

ATARI

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Sunnyvale Calif 94086

TITLE POKEY CHIP
CELLS
PAGE 6

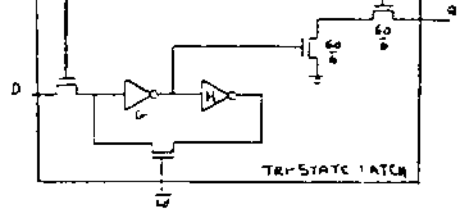
SIZE D DRAWING NO CO12294 REV B

CO12294 40 B

D C B A

4 3 2 1

1



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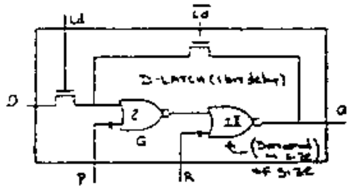

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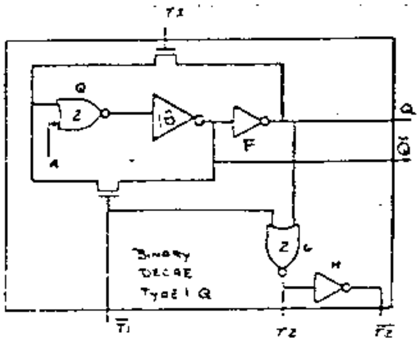

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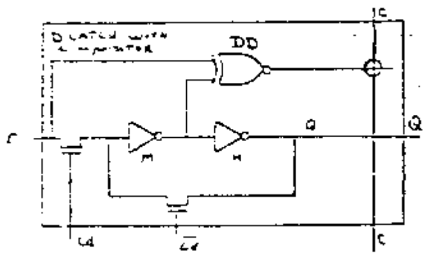

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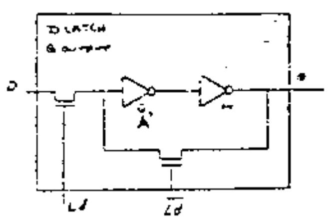

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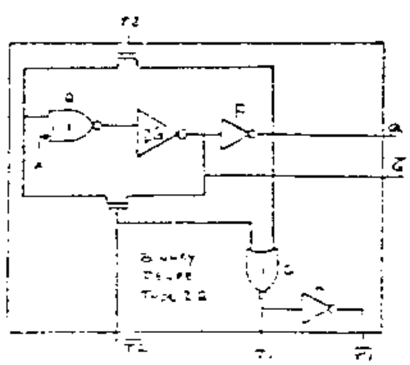

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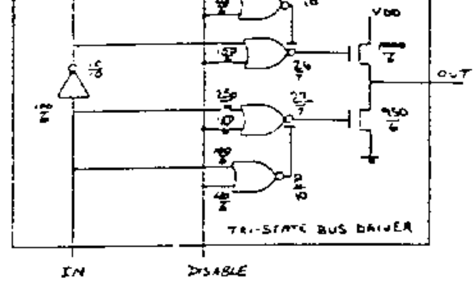

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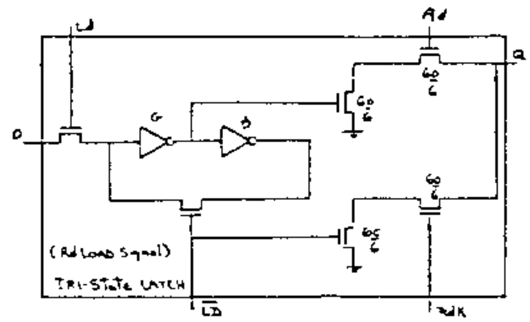

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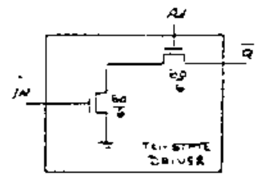

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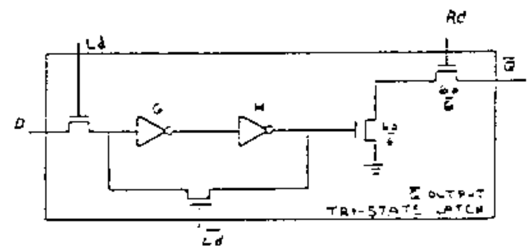

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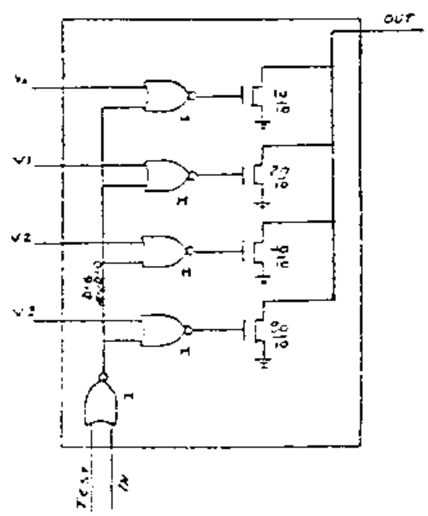

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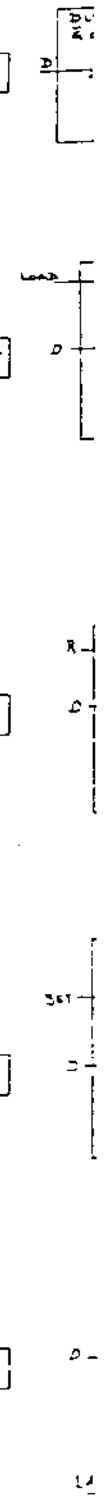
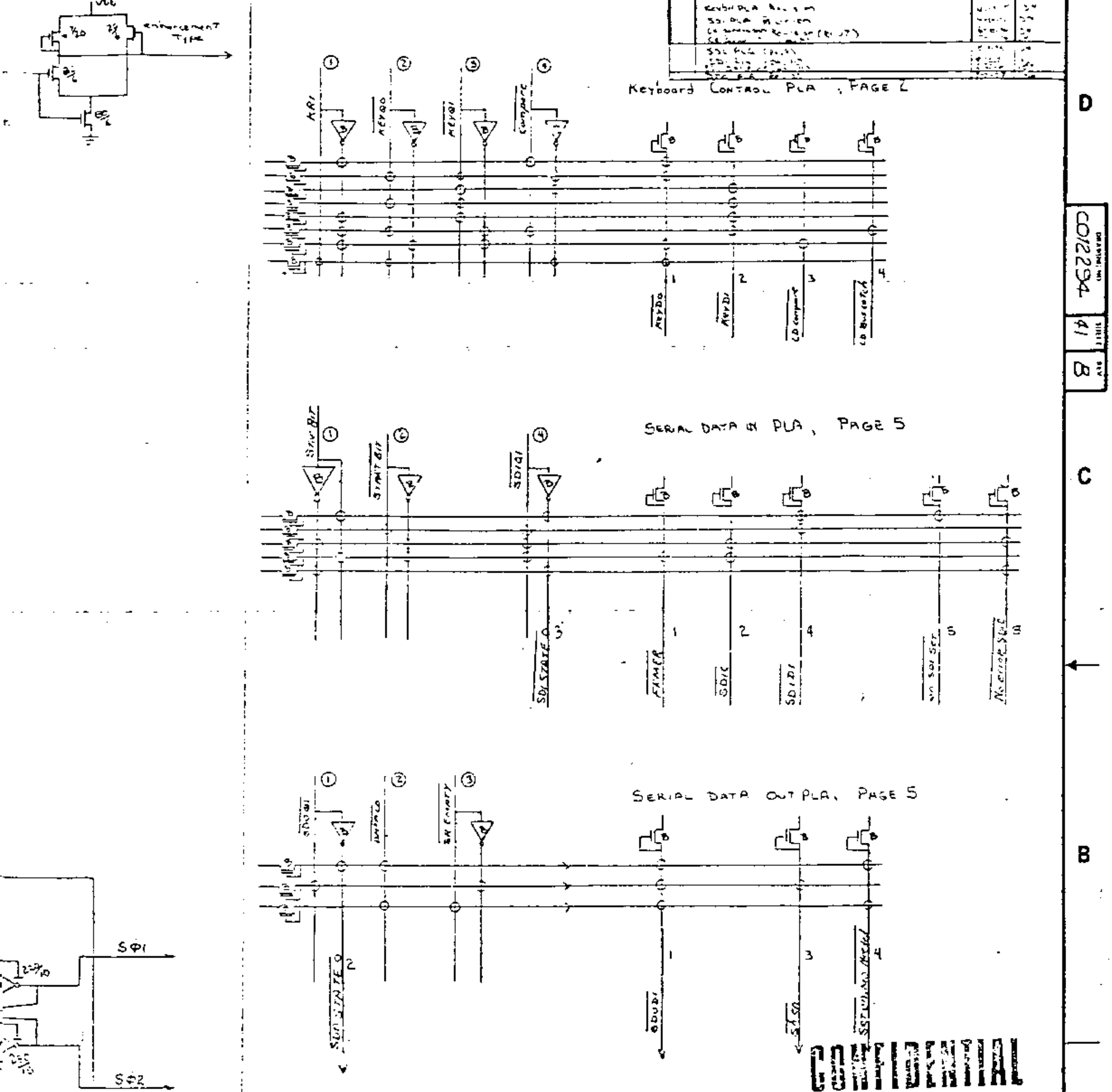




OUTSTANDING ECNs	

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

MATERIAL

FINISH

DO NOT SCALE DRAWING

DRAWN BY | DATE

CHECKED

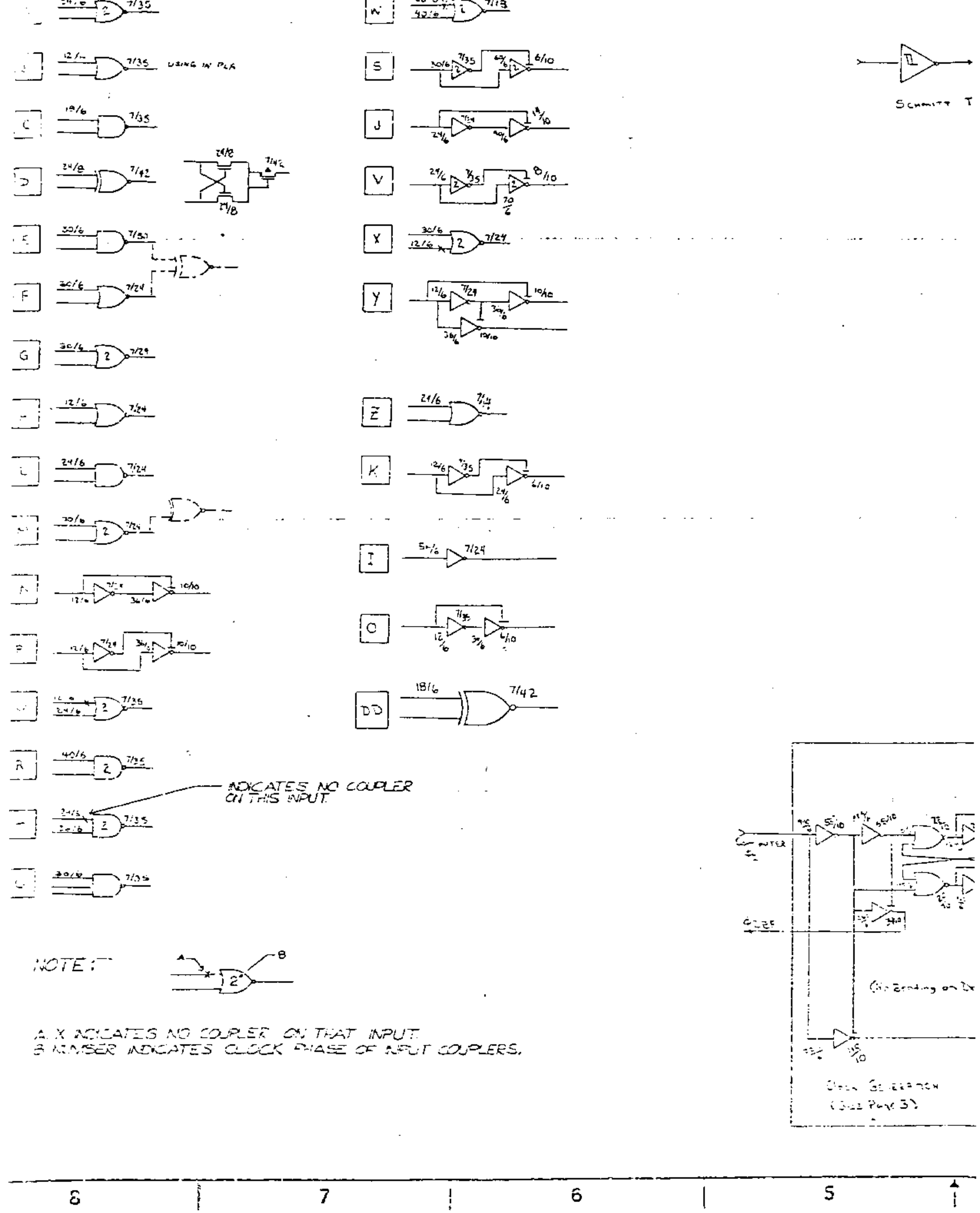
ENGINEER

PROJECT ENGINEER

ATARI — Atari Inc. 1265 Borregas Avenue Sunnyvale, Calif. 94086

TITLE: POKEY ... PLA DETAILS ... PAGE 7

SIZE: D | DRAWING NO: C012294 | REV: B



USING IN PLA
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INDICATES NO COUPLER ON THIS INPUT.
CLOCK GENERATION (SEE PAGE 3)
NOTE:
A. X INDICATES NO COUPLER ON THAT INPUT.
B. NUMBER INDICATES CLOCK PHASE OF INPUT COUPLERS.
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