ENGINEERING NOTEBOOK

ATARI®

ENGINEERING NOTEBOOK

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INSTRUCTIONS

1. All engineering notes, sketches, schematics, etc., are to be recorded in this book. *Glue* any inserts into the book, do not use tape.
2. Complete each sheet in its entirety, but start a new sheet on every new day that you wish to record information.
3. Date and sign each log sheet.
4. All log sheets containing information that might have particular significance must be signed and dated by one witness who reads the sheet and understands its contents.
   NOTE: If there are co-inventors, both should sign in the area marked *WRITER*, and a third party is required to sign as witness.
5. UNDER NO CIRCUMSTANCES MAY ANY PAGE BE REMOVED FROM THIS BOOK.
6. When copies are required, the entire book is to be submitted to the duplicating room, where the specified pages will be reproduced.
7. Under no circumstances may this book be duplicated for personal reasons or removed from the company premises, except by authority of the Engineering Manager.
8. If changes to a page are made, initial and date the changes.

TIPS ON HOW TO USE THIS BOOK:

1. Use black ink. Do not use blue ink or pencil; it is difficult to reproduce.
2. Do not try to erase. If revisions or changes are necessary, cross out and rewrite. See item 8 of instructions.
3. Clarity is essential but precision drawings are not required; therefore, free-hand sketches are acceptable.

Book No. 76181 ***Assigned to*** Dan Kramer

10/2/80 Dan Kramer #10222

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ENGINEERING LOG SHEET

GAME OR PROJECT: ~~C4K RAM~~ OS CARD

PARTS LIST

PART (VALUE)	TYPE COMPONENT ~~REF DESIG.~~	QTY.	REF. DESIG.	COMMENTS	KITTED	ON ORDER
.1 µf	CAP	2	C401, C405		X	
.01 µf	"	1	C404		X	
.001 µf	"	1	C402		X	
o - 20 pf	"	1	—			✓
o - 47 pf	"	2	C407 C409			✓
68 pf	"	2	C408, C410		X	
o - 4.7 µf	"	1	—		X	
- 5-35 pf	VAR. CAP.	1	—			
- 22 µH	INDUCTOR	3	L401 - L403			✓
o - IN4002	DIODE	2	—			
1 Ω	RESISTOR	1	R404		X	
4.7k Ω	RESISTOR	2	R401, PULLDOWN		X	
2.2k	"	1	R402		X	
470	"	1	R403		X	
220	"	1	—		X	
< 10k	"	12	— ~~POT~~	PULLUPS	X	
100 Ω	"	1	—	1/4 WATT	X	
74LS00 ~~7400~~	I.C.	1	Z402	NAND QUAD	X	
74LS09 - ~~7409~~	"	1	Z403	AND QUAD		✓
74LS138	"	1	Z401		X	
- 2716	"	1	—	EPROM (2k x 8) JAN BOOTM		
74LS10	"	1	A14		X	
74LS158	"	1	—		X	
AM27LS0	"	2	—	RAM (4x16)		✓
6520	"	1	—		X	
MSM5832	"	1	—	µP CLOCK/CALENDAR		✓
MX94F	CRYSTAL	1	—	32.768 kHz		✓
79-42C18(ATARI)	SOCKET	1	—	18 PIN		✓

WRITER	DATE	WITNESS	DATE
DAN KRAMER	10/2/80		

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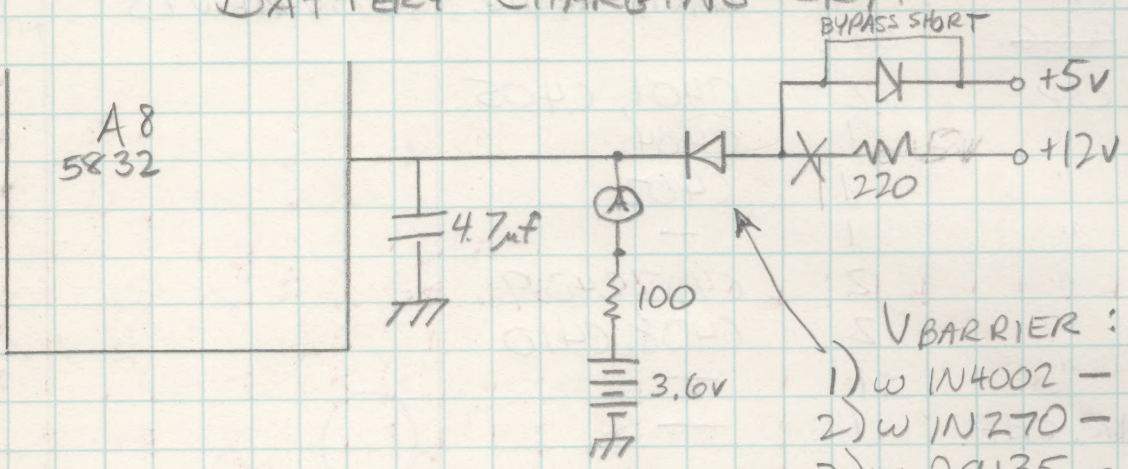
GAME OR PROJECT: O.S. CARD — 10/9/80

BATTERY CHARGING CKT.



VBARRIER:

1) w IN4002 – .6v DROP, V_{cc}=4.3v
2) w IN270 – .38v " , V_{cc}=4.6
3) w R9135 – .35v " , V_{cc}'=4.6v

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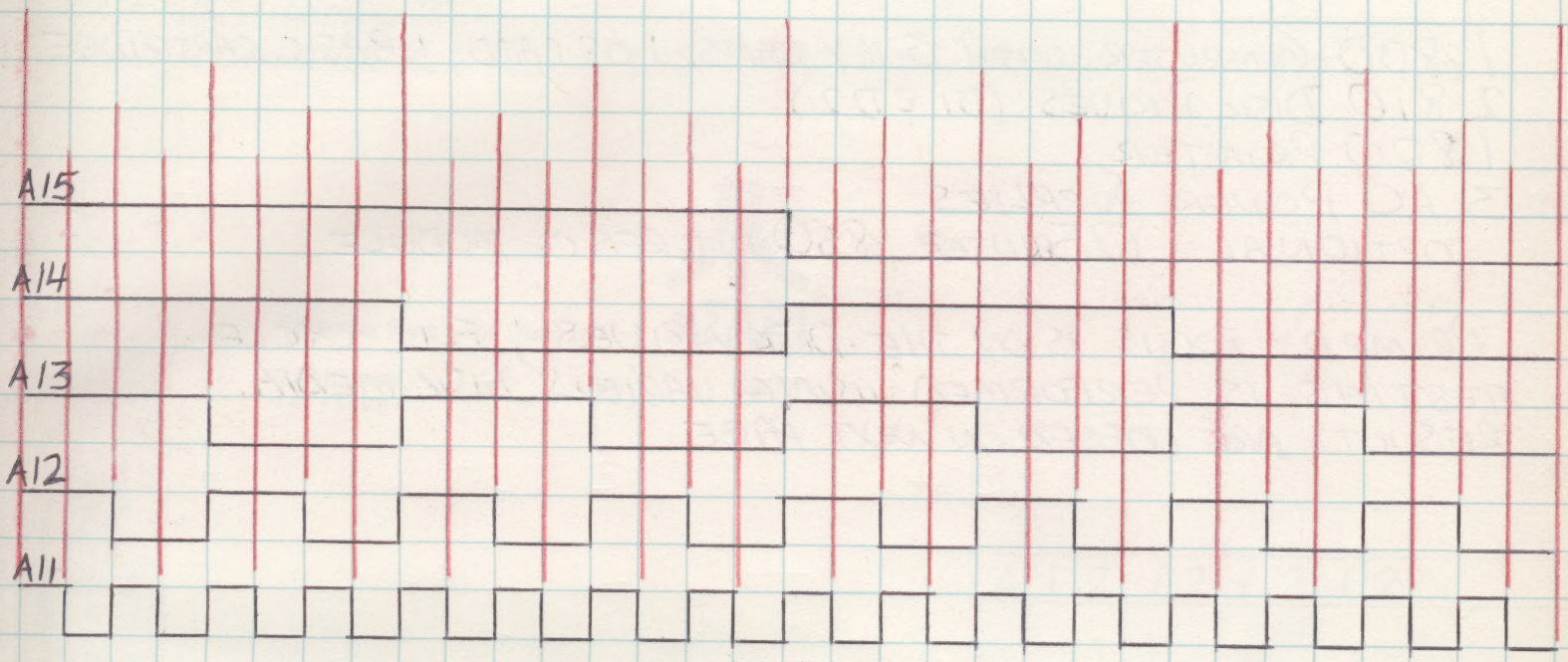
GAME OR PROJECT

HEXADECIMAL ADDRESS CODE



SERIAL NO's.

800 COMPUTER 002 8511
810 DISK DRIVE 21140
820 PRINTER 05123

WRITER	DATE	WITNESS	DATE
DK	10/14		

4 COMMAND POST

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT
PRODUCT RELIABILITY TESTING

18 TEST STATIONS BUILT UP. EACH CONTAINS:

1 800 COMPUTER WITH 3 16K RAMS, 1 OS CARD, 1 BASIC CARTRIDGE
2 810 DISK DRIVES (D1 & D2)
1 820 PRINTER
3 AC POWER SUPPLIES
OPTIONAL: 825 PRINTER, 850 INTERFACE MODULE

PRIMARY FOCUS IS ON THE DISK DRIVES; FULL CYCLE TESTING IS PERFORMED USING VARIOUS DISK MEDIA. RESULTS ARE LOGGED ON NEXT PAGE.

WRITER	DATE	WITNESS	DATE
DK	10/22		

w/ BAR GRAPHS

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ENGINEERING LOG SHEET

GAME OR PROJECT

GREEN LETTER = REPEATED PREVIOUS MODE

P = PASS
F = FAIL
RED LETTER
~~COLOR CHANGE~~ = OPPOSITE OF PREVIOUS PASS/FAIL MODE

	OLD DOS CODE WORKS FLAWTEST III 10/17/80		NEW DOS (MEMORY) FLAWTEST III 10/21		NEW DOS EXERD1 10/21		NEW DOS, EXERD1 10/22															
DRIVE	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1	F	F	F	F	P			F														
2	P	F	P	F	P			F														
3	P	P	P	P	P			P														
4	F	F	F	F	F	F		F														
5	F	F	F	F	F	F		F														
6	P	P	P	P	P			P														
7	P	F	P	F	P			F														
8	F	F	F	F	P			F														
9	F	P	F	P	P			P														
10	P	P	P	P	P			P														
11	P	F	F	F	F			F														
12	P	P	F	P	P			P														
13	P	F	P	F	F			F														
14	P	P	P	P	P			P														
15	P	F	P	F	F			F														
16	P	F	P	F	P			F														
17	P	F	P	F	P			F														
18	F	F	F	F	F			F														

WRITER	JK	DATE	10/22	WITNESS		DATE	

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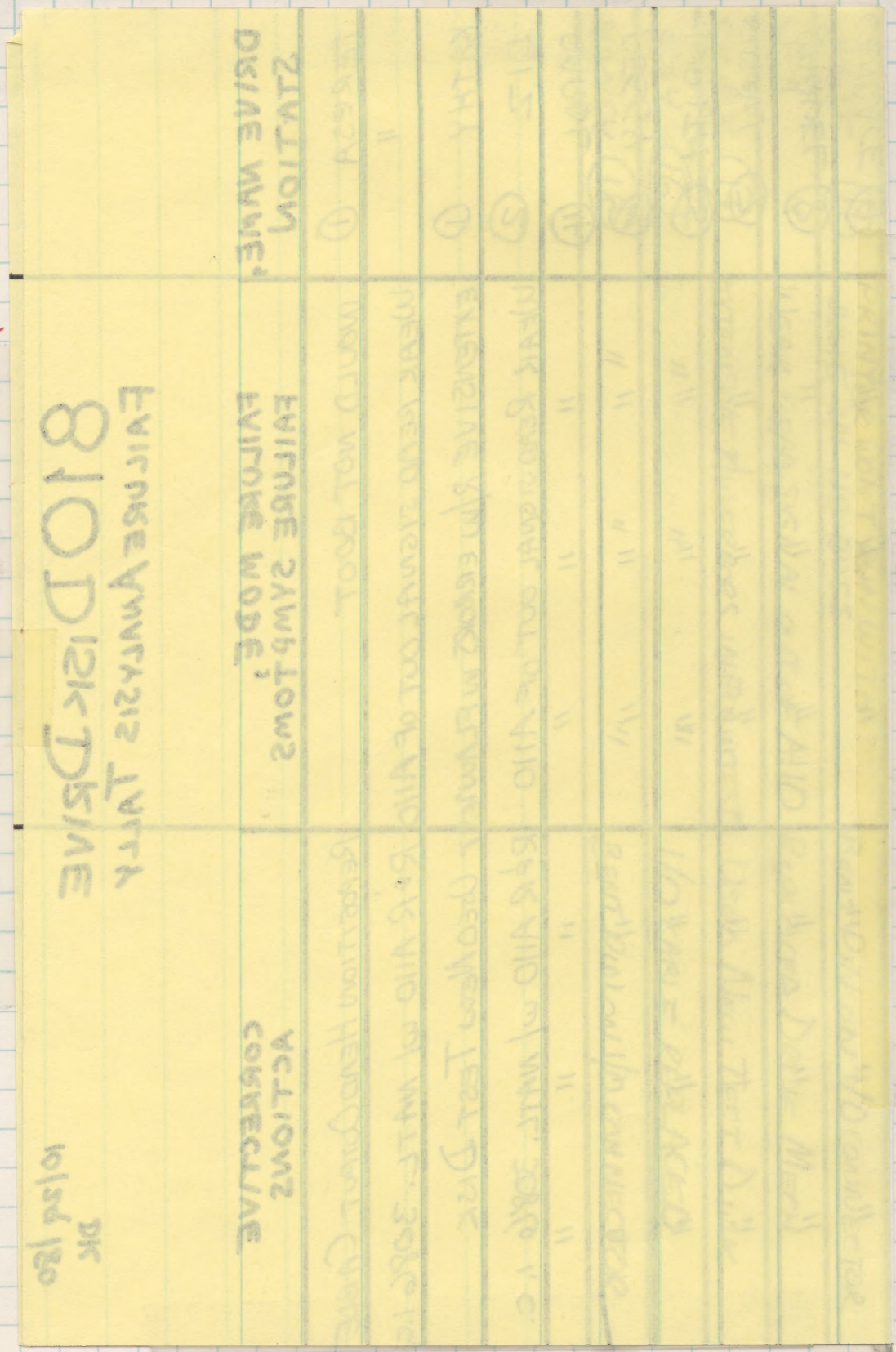
GAME OR PROJECT: 810 DISK DRIVE READ CIRCUIT ANALYSIS:

3086 XISTOR ARRAY FREQ. RESPONSE TEST

DISK DRIVE FAILURE ANALYSIS TALLY (YELLOW SHT)



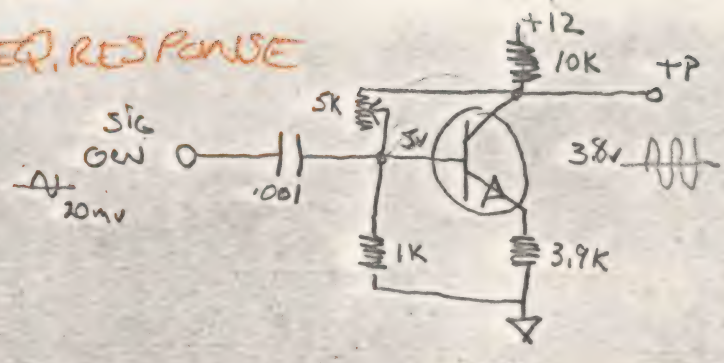
WRITER	DATE	WITNESS	DATE
DK	10/28		

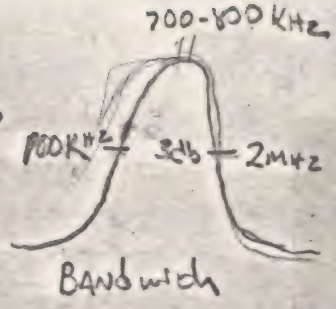
810 Disk Drive
Failure Analysis Tally

10/29/80
DK

DRIVE NAME, STATION	FAILURE MODE, FAILURE SYMPTOMS	CORRECTIVE ACTIONS
TERESA (1)	WOULD NOT BOOT	REPOSITION HEAD OUTPUT CABLE
"	WEAK READ SIGNAL OUT OF A110	R&R A110 w/ NATL. 3086 I.C.
KATHY (1)	EXTENSIVE R/W ERRORS IN FLAWTEST	USED NEW TEST DISK
LIZ (2)	WEAK READ SIGNAL OUT OF A110	R&R A110 w/ NATL. 3086 I. C.
CAROL (4)	" " "	" " "
PEGGY (5)	" " "	" " "
JUDITH (5)	" " "	" " "
SUSAN (7)	" " "	" " "
RAQUEL (8)	" " "	" " "
CANDACE (9)	" " "	" " "
JULIE (11)	PRINTER WON'T RUN WITH JULIE IN I/O BUSS	BENT PIN ON I/O CONNECTOR
" "	WEAK READ SIGNAL OUT OF A110	REPLACED DRIVE MECH.
CINDY (13)	EXTENSIVE R/W ERRORS IN FLAWTEST	USED NEW TEST DISK
FAY (16)	" " "	I/O CABLE REPLACED
NANCY (18)	" " "	BENT PIN ON I/O CONNECTOR

3086 FREQ. RESPONSE





CHIP #		GAIN @	FREQ	APPROX 1db	3db	
001	D	19	600KHz	1MHz	2.1MHz	NATIONAL
	C	19	700KHz	1MHz	2.1MHz	
002	C	19	800KHz	1MHz	2.1MHz	
	D	19	800KHz	1MHz	2.0MHz	
003	D	19	700KHz	950KHz	2.0MHz	
00[illegible]	C	19	725KHz	950KHz	2.1MHz	
004	C	19	800KHz	1MHz	2.0MHz	
	D	19	700KHz	1MHz	2.1MHz	
005	D	19	700KHz	900MHz	2.1MHz	
	C	19	750KHz	900MHz	2.0MHz	
006	C	19	700KHz	1MHz	2.1MHz	
	D	19	700KHz	1MHz	2.0MHz	
007	D	18	750KHz	900KHz	2.0MHz	RCA
	C	18	750KHz	900KHz	2.0MHz	
008	C	18	750KHz	950KHz	1.9MHz	
	D	18	750KHz	950KHz	2.0MHz	
009	D	18	750KHz	1MHz	1.9MHz	
	C	18	725KHz	1MHz	2.0MHz	
010	C	18	750KHz	1MHz	2.0MHz	
	D	18	700KHz	950KHz	2.0MHz	
011	D	18	700KHz	950KHz	2.0MHz	
	C	18	700KHz	950KHz	2.0MHz	
012	C/D	18				

3086 XISTOR ARRAY FREQ. RESPONSE TEST

ATARI **ENGINEERING LOG SHEET**

GAME OR PROJECT
810 MOTOR SPEED COMPATABILITY TEST

PURPOSE: DETERMINE LIMITS OF MOTOR SPEEDS WHICH CAN BE USED ON DIFFERENT DRIVES AND STILL MAINTAIN INTERCHANGE MEDIA COMPATABILITY

TEST #1

PROGRAM WRITTEN TO WRITE A DISK FULL OF INFO (EVERY BIT), THEN TO READ BACK AND DISPLAY ANY READ ERRORS IN THE ~~AAAAA~~ INFORMATION RETURNED (WRITE SLOW, READ NORMAL SPEED)

% SPEED VARIATION

REF 0%	305 Hz
-1	302
-2	299
-3	296
-4	293
-5	290
-6	~~287~~
-7	284
-8	281
-9	278
-10	275

TEST DISCREPANCY - COULD NOT EFFECTIVELY ~~FORMAT~~ WRITE DISKS CONSISTENTLY AT ANY SPEED BELOW 300 Hz - SUSPECT THE INDEXING OF THE DISK WOULD NOT FUNCTION CORRECTLY IF IT WERE ~~AAAAA~~ DISTORTED FURTHER BY SLOWER MOTOR SPEEDS. THE DISK FORMATTING SEEMS TO BE THE MOST CRITICAL FACTOR AFFECTED BY MOTOR SPEED.

TEST #2

11/6/80

(DOS)

USING A DISKETTE WRITTEN @ 277 Hz, THE FOLLOWING RESULTS WERE OBTAINED:

DRIVE NAME, STATION #	RESULT
NANCY (18)	FAILED TO BOOT 100%
PENELOPE (18)	BOOTED OK
JOANNE (17)	BOOTED OK
MISSY (17)	BOOTED OK
FAY (16)	FAILED TO BOOT ABOUT 50%
ESTHER (10)	BOOTED OK
JEAN (15)	WOULDN'T BOOT 2nd HALF (ERROR 10, LINE 17735)
GAIL (15)	BOOTED OK
~~SALLY~~ LUCY (14)	WOULDN'T BOOT 2nd HALF (ERROR 10, LINE 17735)

DRIVE NAME, STATION #	RESULT
LYNNE (2)	BOOTED OK
DIANE (3)	FAILED TO BOOT
KAREN (4)	FAILED
BETTY (6)	BOOTED OK
JULIE (11)	FAILED TO BOOT
ANNE (12)	WOULDN'T BOOT 2nd HALF (ERROR 10, LINE 17735)

THESE DRIVES WERE MODIFIED TO +12V SUPPLY ON STEPPER MOTOR

THESE WERE NOT

WRITER	DATE	WITNESS	DATE
DK	10/30		

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT
810 MOTOR SPEED COMPATABILITY (CON'T.)

ANALYSIS OF DRIVES FAILING 277 Hz-WRITTEN DISK TEST

JEAN (15) : MOTOR SPEED UPON OPENING UNIT WAS 310Hz; DRIVE BOOTED OK WHEN SPEED LOWERED TO 300-305 Hz
LUCY (14) : INITIAL MOTOR SPD. 300 Hz, WOULDN'T BOOT; OK WHEN LOWERED TO TO 295 Hz
NANCY (18) : INITIAL M.S. 305 Hz, BOOTED OK @ 295 Hz
FAY (16) : WOULDN'T FAIL TO BOOT AT TEST BENCH
DIANE (3) : INITIAL M.S. 305 Hz, WOULDN'T BOOT, OK WHEN LOWERED TO 300 Hz
KAREN (4) : WOULDN'T FAIL TO BOOT AT TEST BENCH
JULIE (11) : INITIAL M.S. 310 Hz, WOULDN'T LOAD DOS Pt.2, OK WHEN LOWERED TO 303Hz
ANNE (12) : INITIAL M.S. 305 Hz, WOULDN'T BOOT; OK WHEN LOWERED TO 294 Hz

NOTES & COMMENTS

(1) The first Motor Speed Test used a 5% slow-written (290 Hz) diskette full of "49" & "92" data bytes. All ten of the drives (DI) at stations 1-10 were tested with this diskette, all [redacted] read data OK
(2) The second Motor Speed Test used a 277-Hz-written copy of the DOS as software. Partial reading occurred on drives which failed to boot the DOS, and all drives were able to successfully boot by lowering the speed no more than 10 Hz if they could not @ 305 Hz! No other extenuating factors affecting the ability of a drive to read the slow DOS were readily noted.
(3) A basic conclusion about speed variation seems to be that there is a maximum limit of 25 to 30 Hz variation allowable between write & read speeds for effective interchange of the media.

WRITER DK	DATE 11/10	WITNESS	DATE

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ENGINEERING LOG SHEET

GAME OR PROJECT
810 MOTOR SPEED REPEATABILITY TEST

TEST DRIVES : JULIE (11) w/ RCA 3086 IN MOTOR SPD. CIRCUIT
JEAN (15) w/ NATL 3086 IN MOTOR SPD CIRCUIT

MOTOR
SPEED OF THESE 2 DRIVES WAS NOTED TO BE 310 Hz WHEN CHECKED ON LAST TEST, SHOULD HAVE BEEN 305 Hz AS SET ORIGINALLY. RUN A LONG-TERM BURN-IN TO MONITOR ANY POSSIBLE CHANGES IN SPEED.

AT COLD START-UP :	JEAN	308-309
	JULIE	308-309
AFTER 15 MINUTES	JEAN	305
W/ DRIVE TURNED ON :	JULIE	305-306
AFTER 3 1/2 HOURS OF	JEAN	295-296
CONTINUOUS MOTOR RUN :	JULIE	293
AFTER DRIVE RUN FOR	JEAN	303
10 HRS. AND SET W/ POWER	JULIE	304-305
ON FOR 9 HRS :		

WARMUP OF THE DRIVE WAS DIRECTLY RESPONSIBLE FOR THE CHANGE IN MOTOR SPEED. THIS WILL DEFINITELY AFFECT MEDIA INTERCHANGE BETWEEN DIFFERENT DRIVES.

WRITER DK	DATE 11/11	WITNESS	DATE

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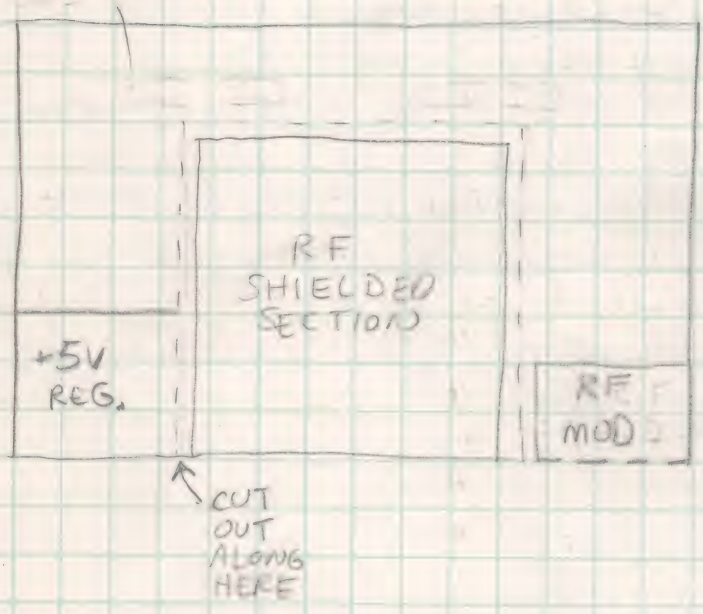
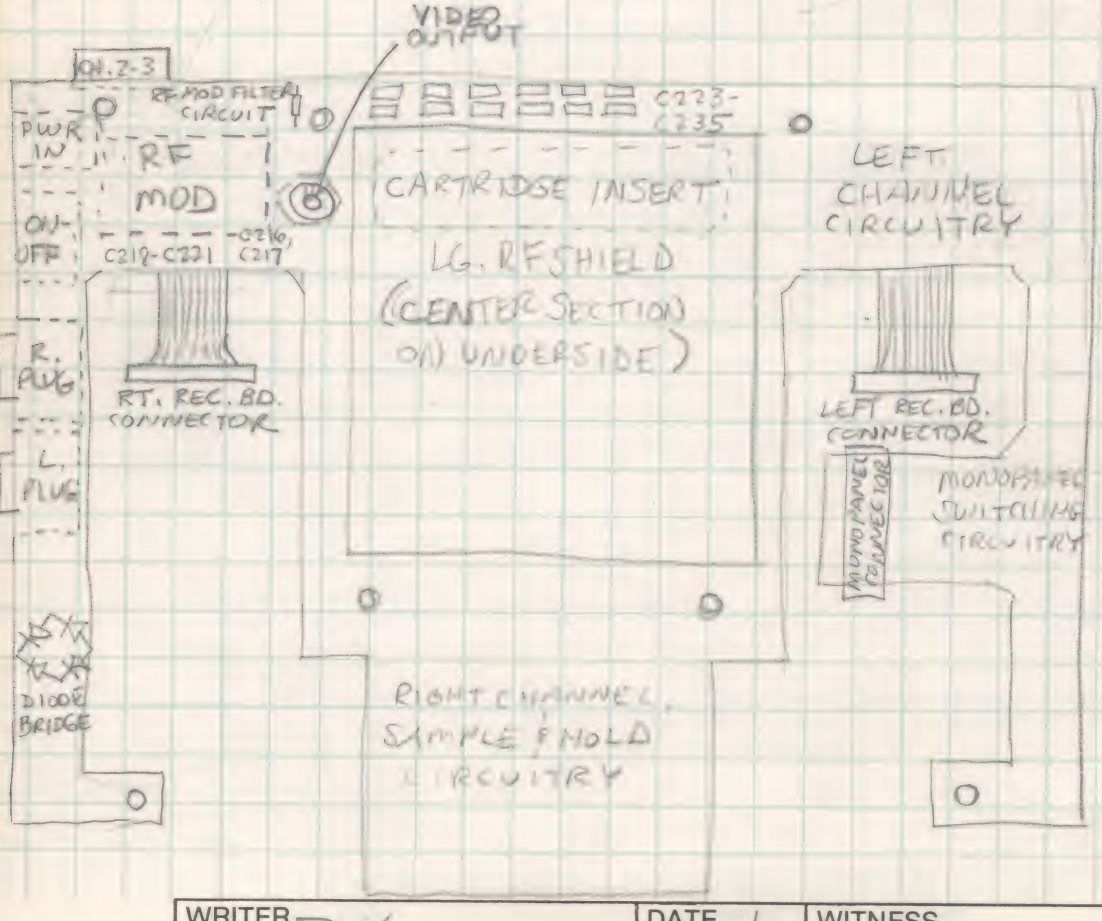
GAME OR PROJECT: RC STELLA PROTO UNIT [redacted] #1

MAIN BOARD CUTUP



UNDERSIDE VIEW (COMPONENT SIDE)



WRITER	DATE	WITNESS	DATE
DK	12/10		

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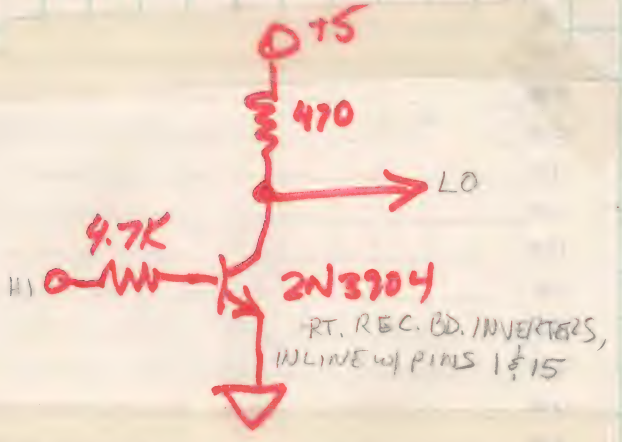
GAME OR PROJECT: RC STELLA PROTO #1

WIRE COLOR, #	ORIGIN	DESTINATION	MAIN BOARD
BLK 1	A201 PIN 37	R PLUG PIN 9, 1.8K RES,	
BRN 2	" 38	" 5 " ,	
OR 1	" 39	L PLUG PIN 9 " ,	R SAMPLE-HOLD OUTPUT
RED 1	" 40	" 5 " ,	L "
BRN 1	R225 (220Ω)	R PLUG PIN 6, 470pf CAP,	R 74LS244 PIN 5
RED 2	R224 (220Ω)	L " 6 " ,	L 12
YEL 1	A202 PIN 12	L PLUG PIN 1, .001 CAP,	L 74LS244 PIN 9
GRN 1	" 13	" 2, " ,	" 7
BLU 1	" 14	" 3, " ,	" 5
VIO 1	" 15	" 4, " ,	" 3
GRN 2	" 8	R PLUG PIN 1, " ,	R " 7
BLU 2	" 9	" 2, " ,	" 9
VIO 2	" 10	" 3, " ,	" 12
GREY 2	" 11	" 4, " ,	" 14
GREY 1	" 16	74LS279 PIN 13, "	
WHT 1	" 17	" 7, "	
WHT 2	" 21	" 4, "	
YEL 2	" 23	RT. 74LS244 PIN 16, "	
OR 2	" 24	" 18, "	
BLK 2	+5V BLINE	+5V REGULATOR BD.	
BRN 3	A201 PIN 10	" (POT OUTPUT)	
RED 3	C215, R222	RF MODULE PIN 4	MONOPANEL



TRANSISTOR INVERTER

WRITER DK	DATE 12/10	WITNESS	DATE

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ENGINEERING LOG SHEET

GAME OR PROJECT: RC STELLA COMMANDER PROTO RUN

UNIT #	FREQ.	MAIN FRAME #	CHANNEL
1	49.740 MHz		
2	49.760		
→ 3	49.960	1	
→ 4	49.780	1	
5	49.800	4	R
6	49.980	4	L
7	49.920		
8	49.960		
9	49.740	2	R
10	49.940	2	L
11	49.760	3	R
12	49.800		
13	49.980	4	L
14	49.920	2	L
15	49.960		
16	49.940	3	L

WRITER	DATE	WITNESS	DATE
JK	12/19		

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ENGINEERING LOG SHEET

GAME OR PROJECT: R.C. STELLA — CORRECTION NOTES FOR PROTO RUN

NOTED DISCREPANCIES & FLAWS

1) PADDLE JITTERS WHEN IDLING IN REMOTE
2) POT IN THE TRANSMITTER IS LOG, NOT LINEAR!

OUT TO LUNCH AT N.Y. PRESS CONF.: SEL-RES LIGHTS STUCK ON IN REMOTE MODE WHEN PLAYING 'BASKETBALL' WOULD NOT RESUME NORMAL MODE UNDER ANY CIRCUMSTANCES. SWITCHED TO 'CIRCUS ATARI' AND FAILURE STOPPED [JOYSTICK VS. PADDLE?]

845-890 UNIT

WRITER	DATE	WITNESS	DATE

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GAME OR PROJECT: RC STELLA — CHANGES TO MAIN BOARD

(1) 74LS01 : SWITCH PINS 11 & 13, PINS 8 & 10

(2) 74LS279 : SWITCH PINS 5 & 6 (POT & JOYSTICK PINS 6 & 12 ON MONO PANEL)

(3) FOR EACH 2N3906 (L & R) ON OUTPUT OF LM324:
- A] BASE INPUT R SHOULD BE 22k, NOT 6.8k
- B] BASE - V_{cc} R SHOULD BE 10k, NOT 22k
- C] EMITTER - V_{cc} R SHOULD BE 6.8k, NOT 10k

(4) DISCONNECT LS244 PIN 11 FROM LINE LEADING TO THE 220Ω INPUT RESISTOR FOR A201 PIN 35; CONNECT INSTEAD TO PIN 14 ON THE 244 I.C.

WRITER	DATE	WITNESS	DATE
DK	3/9/81		

2-27-81 | CARL NIELSEN | MATTEL | INTELLIVISION

IC LIST (GAME ONLY - NO CARTRIDGE IC's)

P.C-BOARD 6½" x 8½"

# 1	RO-3-9503-003	7943	ROM	40 PIN	GRAPHICS ROM+LOGIC, 2048X
* # 2	AY-3-8900-1	7946	STIC	40 PIN	(STANDARD TV INTERFACE CHIP) HEAT SIN
# 3	AY-3-8914	7944	SOUND	40PIN	SOUND CHIP
# 4	RA-3-9600	7944	RAM	40 PIN	SYSTEM RAM+LOGIC, 352X
# 5	CP-1610	7804		40 PIN	MICRO PROCESSOR HEAT
	16 BIT (DATA AND ADDRESS ON THE SAME BUS, 65K MAX). 2MHz, +11V, +5				
# 6	RO-3-9502-011	7939	ROM	40 PIN	2048X10 BITS, PROGR R
# 7	RO-3-9504-021	7939	ROM	28 PIN	PROGRAM ROM+LOGIC 20 10
# 8	3539 UCP (SEMI)	7938		22 PIN	256X8 RAM $2.00
# 9	" "	"	"	"	" " $2.00
# 10	" "	"	"	"	" " $3.00
# 11	AY-3-8915	7921	COLOR	18 PIN	16 COLORS
# 12	F-7407PC	7918	SINGAPORE	14 PIN	40¢
# 13	74LS86N	7933		14 PIN	
# 14	SN74LS27N TI	7927	EL SALVADOR	14 PIN	
# 15	DM74LS00N NSC	929		14 PIN	
# 16	DM74LS125N NSC	7917		14 PIN	
# 17	DM74LS125N NSC	7917		14 PIN	

IC LIST (CARTRIDGE - PC BOARD, 2.5"x2.5", 2 shields, 2 cap

# 1	RO-3-9504-107	7944	ROM	28PIN	2048X10 BITS, ROM+LOGIC
# 2	RO-3-9504-207	7946	ROM	28PIN	2048X10 BITS, ROM+LOGIC

50¢

ADOLFO
2777

GAME OR PROJECT

DISSECTION OF INTELLIVISION

POWER SUPPLY

10,000 µf 16v CAP
2200 µf 25v CAP
100 µf 16v CAP
APPROX 20 DECOUPLERS (.001, .01 OR .1 µf)
7805 C REGULATOR, HEATSINK (DOUBLE)
7812 C " "
3 MOLEX CONNECTOR'S (5, 5 & 2 PINS)
12 Ω 1 WATT RESISTOR
LINE XFORMER

MAIN BOARD

7943	40-PIN ROM (GRAPHICS)
7946	40-PIN T/A
7944	40-PIN SOUND
7944	40-PIN RAM (SYSTEM)
7804	40-PIN MPU
7939	40-PIN ROM (2K x 10)
7939	28-PIN ROM (PROG. LOGIC)
(3) 7938	22-PIN RAM (256 x 8)
7921	18-PIN COLOR (16 COLORS)
7918	7407 PC
7933	74LS86
7927	74LS27
929	74LS00
7917	74LS125

22 RESISTORS
25 DECOUPLERS (.001, .01 OR .1 µf)
2 2N3906, 1 2N3704 X'ISTORS
10 FERRITE BEADS
5 SM. ELECTROLYTIC CAPS
1 TRIMMER CAPACITOR
1 7159.090 KHz CRYSTAL

MISC.

POWER ON-OFF SWITCH
RF SHIELDS FOR MAIN BD.

CONTROLLERS

9-PIN OUTPUT CONNECTOR, CORD w/ MOLEX
PLASTIC-DOMED SWITCH PANEL
(0-9, CLEAR, ENTER)
4 PUSH-BUTTON ACTIVATED SWITCHES
ON SIDES OF UNIT
LG. FERRITE BEADS ON CORDS

4 STANDARD DIODES
3 SM. DISC CAPACITORS
1 22-PIN CARTRIDGE EDGE CONNECTOR
1 RIBBON CONNECTOR (5 PIN)
3 MOLEX CONNECTORS (9, 9 & 2 PINS)
1 5-PIN RF MODULATOR
1 DOME SWITCH (RESET)
3 HEAT SINKS (40-PIN I.C.)
CH 3-4 SLIDE SWITCH

WRITER	DATE	WITNESS	DATE
JK	3/17		

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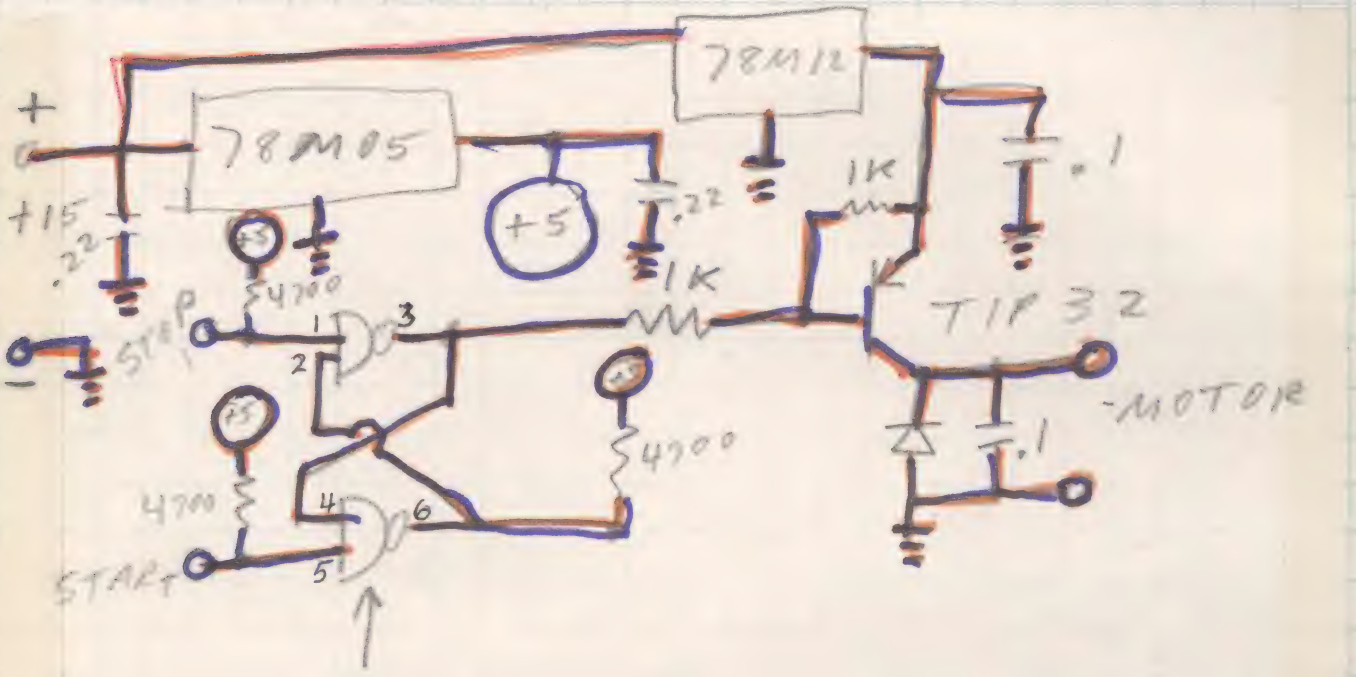
ENGINEERING LOG SHEET

GAME OR PROJECT: MOTOR DRIVE CKT.



74LS01
Pin 14 +5
Pin 7 -

WRITER JC	DATE 4/3	WITNESS	DATE

GAME OR PROJECT

BAR GRAPH - LED DISPLAYS

MV57173

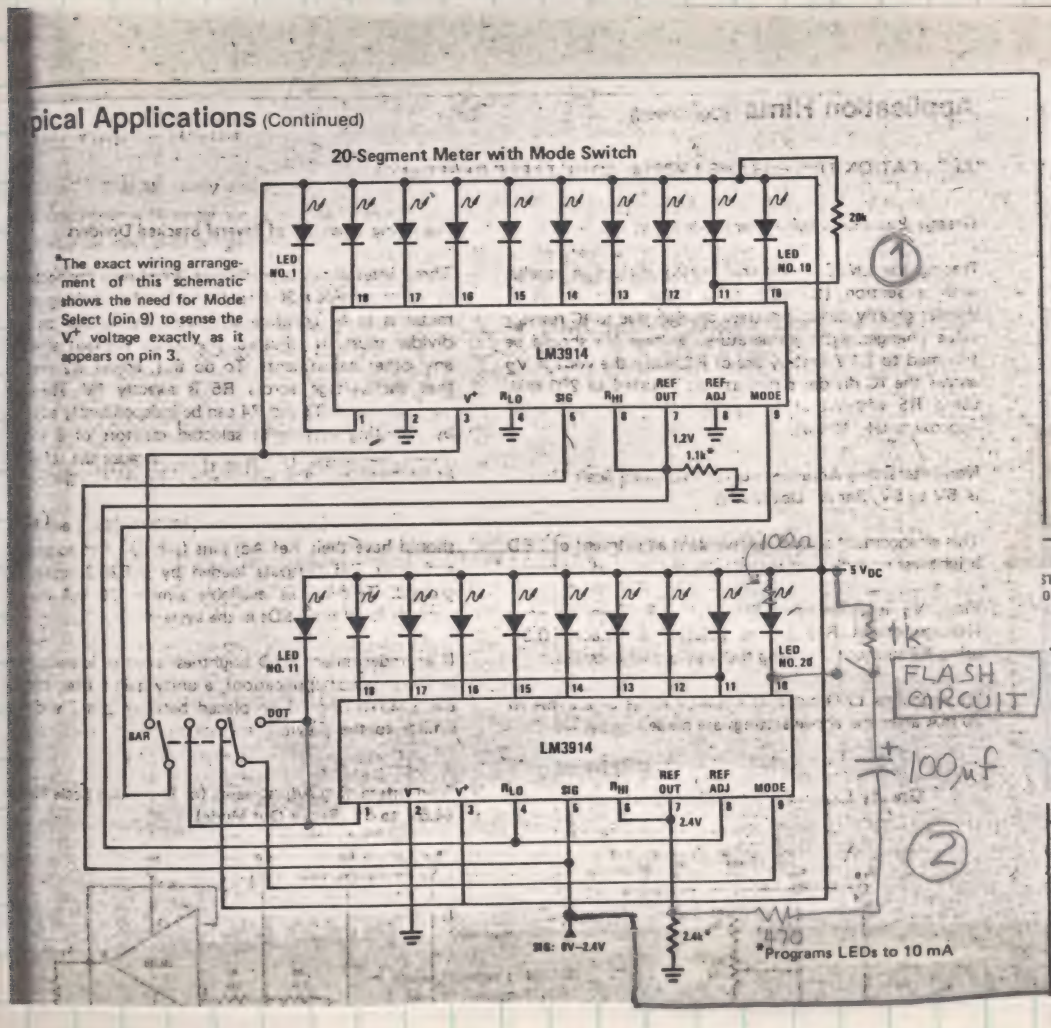
DOUBLE LEDS IN HOLDERS:
ALLOW 3/4" FOR EACH INCH LENGTH
20 SEGMENTS = 15" LONG LINE
2 DRIVERS IN SERIES

LM3914

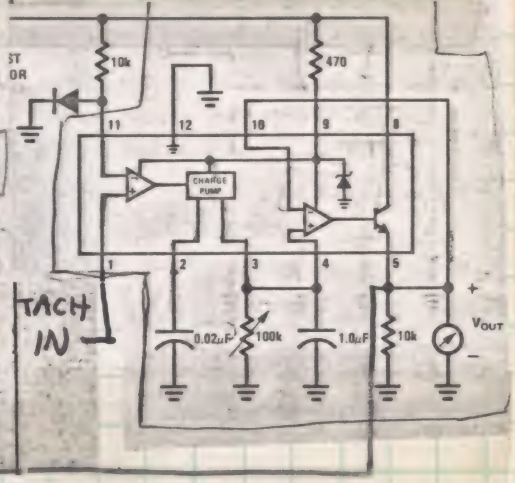
Typical Applications (Continued)

20-Segment Meter with Mode Switch

*The exact wiring arrangement of this schematic shows the need for Mode Select (pin 9) to sense the V^+ voltage exactly as it appears on pin 3.



FREQ - VOLTAGE CONV.
TRAK - BALL TO DRIVER
LM 2917N



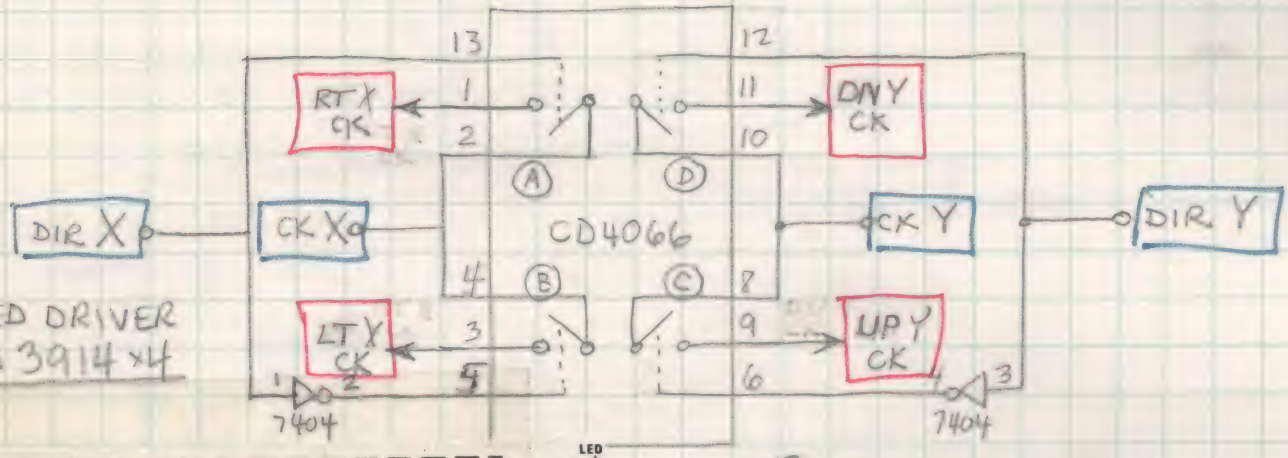
LED TEST CIRCUIT: BAR GRAPH DRIVEN BY #1,
10 DOUBLE LEDS DRIVEN BY #2.
OPTIONS: FLASH AT FULL RANGE, BAR OR DOT MODE,
LED BRIGHTNESS CONTROL

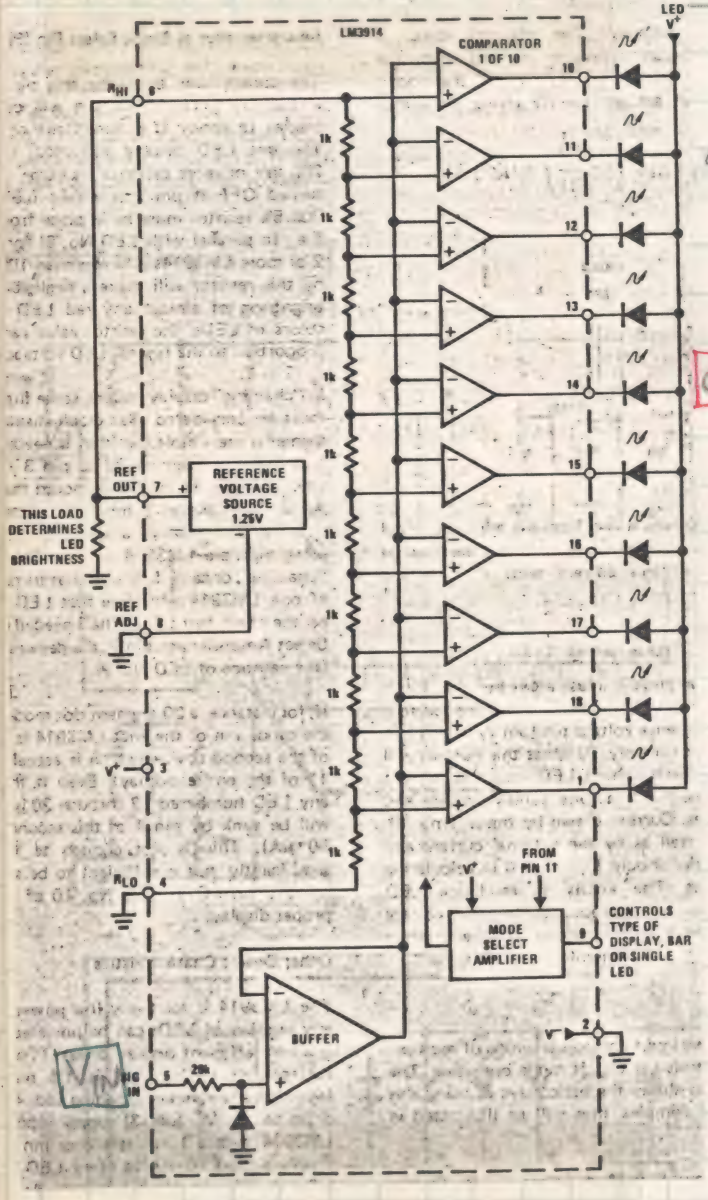
WRITER	DK	DATE	4/3	WITNESS		DATE	

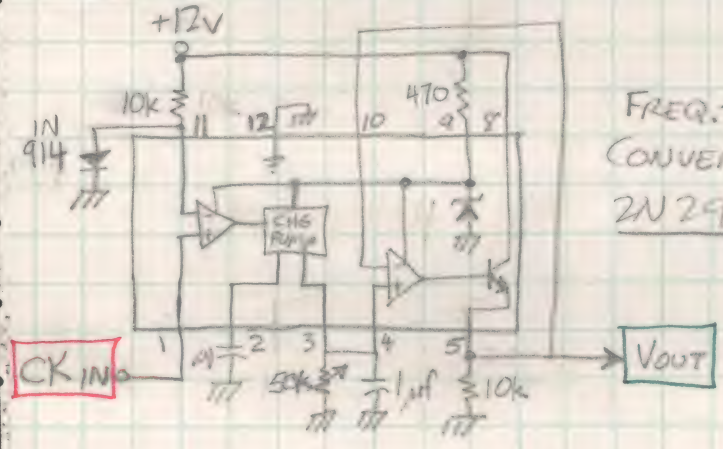
ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT: TRAK-BALL XY BAR GRAPHS

CLOCK SWITCHER







FREQ.-VOLTAGE CONVERTER
2N2917N x4

WRITER	DATE	WITNESS	DATE
DK	4/9		

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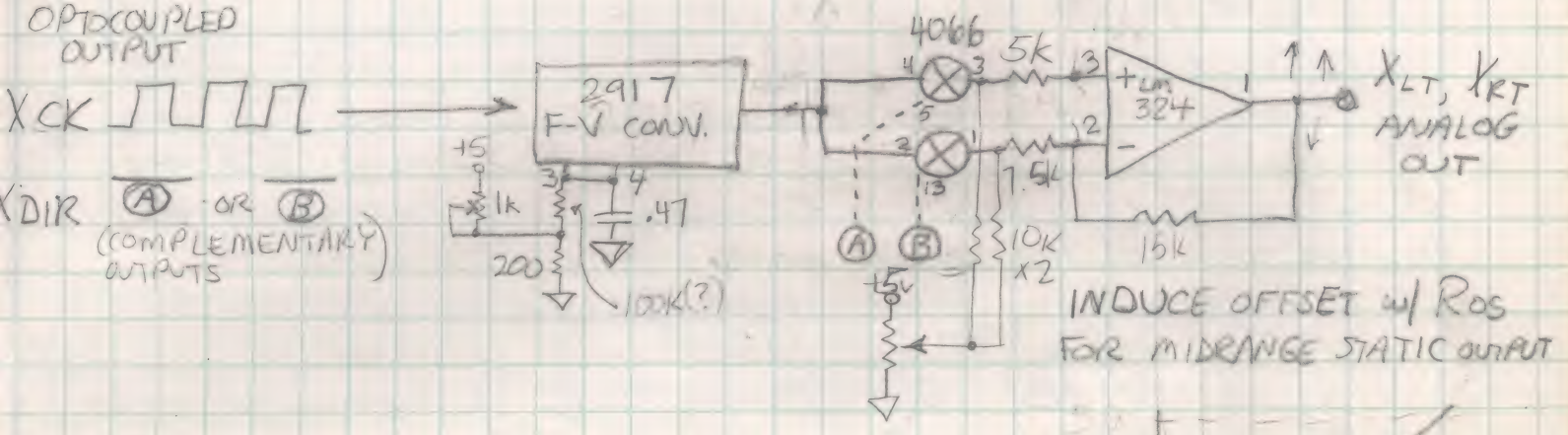
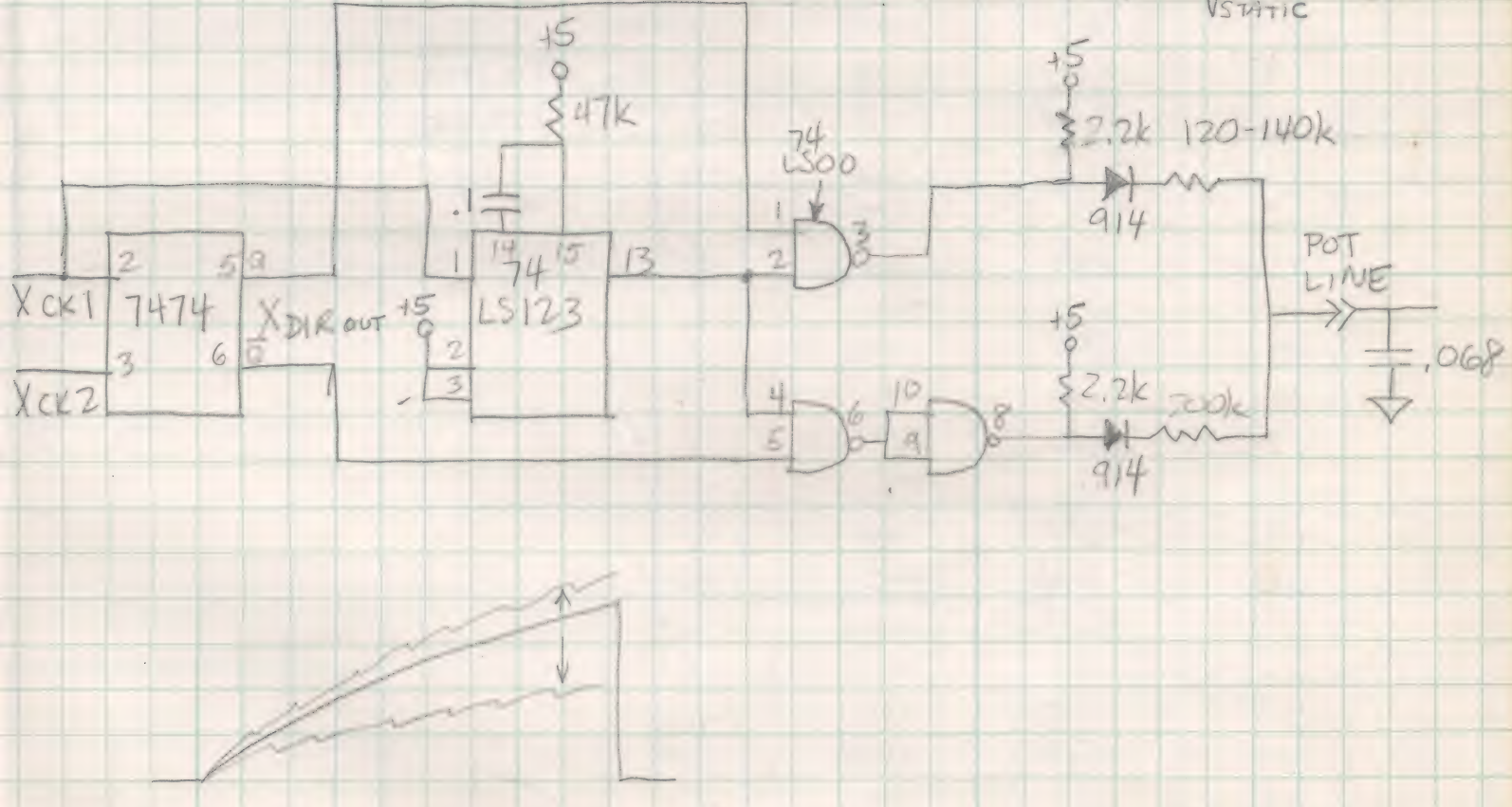
GAME OR PROJECT: **TRAK-BALL D-A CONVERSION**





MODULATES RAMP W/ CURRENT TO SIMULATE POT SIGNAL

WRITER	8/6, 9/2	DATE	WITNESS	DATE

ATARI **ENGINEERING LOG SHEET**

GAME OR PROJECT: 2600 : 1.2 MHz RF MEASUREMENTS

TEST TO DETERMINE LEVEL RANGE OF SPURIOUS SIGNAL CAUSING THE NOTORIOUS "SAILHOUSE EFFECT," REFERENCED TO 0 dBm MAIN SIGNAL LEVEL. VIDEO OUT FROM VCS RUN INTO 7613 SCOPE'S SPECTRUM ANALYZER w/ 30 KHz FILTER TO CUT DOWN NOISE. 6507 MPU CHIPS SORTED ACCORDING TO VARIATION IN 1.2 MHz FREQ. OUTPUT LEVEL.

BLUE DOT CHIPS		ORANGE DOT CHIPS	
CHIP #	LEVEL	CHIP #	LEVEL
1	-64 dB	26	-64 dB
2	-62	27	-66
3	-62	28	-64
4	-62	29	-64
5	-62	30	-64
6	-64	31	-64
7	-64	32	-66
8	-62	33	-64
9	-62	34	-64
10	-64	35	-64
11	-62	36	-64
12	-62	37	-66
13	-66	38	-64
14	-64	39	-64
15	-64	40	-64
16	-64	41	-62
17	-64	42	-64
18	-62	43	-64
19	-64	44	-64
20	-64	45	-64
21	-62	46	-64
22	-62	47	-64
23	-62	48	-64
24	-64	49	-64
25	-62	50	-64

8.3% TUBES → 11

3.3% TUBES → 37

WRITER	DK	DATE		WITNESS		DATE	

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ENGINEERING LOG SHEET

GAME OR PROJECT: COSMOS REV. 0.3 PCB BUILDUP

PARTS LIST DISCREPANCIES:

1. ITEM 5, 220Ω, R106 SHOULD BE R140
2. ITEM 24, XISTOR SHOULD BE 2N3904, NOT 2N2904

STUFFING DIAGRAM DISCREPANCIES:

1. R138, R134 SHOULD BE 560Ω, NOT 470Ω
2. C108, C109 SHOULD BE 360pf, NOT 330pf

WRITER	DATE	WITNESS	DATE

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT: RC STELLA SHOW UNITS

1
L TRANS: 49.8894 MHz (CO16936 XTAL)
R TRANS: 49.8294 MHz (CO16935 XTAL)

L REC: 24.7175 MHz (CO17157 XTAL) 400 μV IN = .8 V OUT

R REC: 24.6875 MHz (CO17156 XTAL) 235 μV IN = .8 V OUT

2
L TRANS:

R TRANS:

L REC:

R REC:

NOT USED FOR SHOW

3
L TRANS:

R TRANS:

L REC:

R REC:

4
L TRANS: 49.8894 (CO16936)

R TRANS: 49.8294 (CO16935)

L REC: 24.7175 (CO17157)

R REC: 24.6875 (CO17156)

WRITER	DATE	WITNESS	DATE

ATARI

ENGINEERING LOG SHEET

GAME OR PROJECT: RC, STELLA SHOW UNITS

CHANNEL ASSIGNMENTS (2 EACH)

		RECEIVER	TRANSMITTER
1	LEFT	24.6425	49.7387
	RIGHT	24.5725	49.5987
2	LEFT	24.7525	49.9587
	RIGHT	24.6025	49.6587
3	LEFT	24.6525	49.7587
	RIGHT	24.5825	49.6187
4	LEFT	24.7325	49.9187
	RIGHT	24.6725	49.7987
5	LEFT	24.7625	49.9787
	RIGHT	24.6225	49.6987
6	LEFT	24.7425	49.9387
	RIGHT	24.5925	49.6387

WRITER	DATE	WITNESS	DATE

ATARI®

ENGINEERING LOG SHEET

GAME OR PROJECT
RC STELLA SHOW UNIT CHECKOUTS

2A: LEFT CHANNEL DOES AUTO SEL-RES. AND PICKS UP R. CHANNEL JOYSTICK COMMANDS [TOO SENSITIVE]
CONTROLLER JOYSTIX OK.
PADDLE CIRCUITS RANGE INCORRECT

2B: LEFT CHANNEL OVER-SENSITIVE, CHANGED DOME SWITCH FOR "DOWN" IN RT. CONTROLLER

3A: LEFT CHANNEL TOO SENSITIVE, CHANGED DOME SWITCH FOR "RIGHT" IN RIGHT CONTROLLER. AUTO-SEL-RES. W/ LEFT XMITTER ON
RT. CHANNEL RANGE 20 FT., LEFT 10 FT.

5A: R. CONTROLLER "RIGHT" & "LEFT" KEEP GOING WHEN STICK IS RELEASED. "R" & "L" DOMES CHANGED

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ENGINEERING LOG SHEET

GAME OR PROJECT

RC STELLA SHOW UNIT CHECKOUTS

4A: "LEFT" DOME ON RT-CONTROLLER CHANGED. "RIGHT" DOME ALSO LOSES CHROMA SIGNAL INTERMITTENTLY: SHIELD SHORTS AGAINST TRACE FROM ADJUSTMENT POT — NOTCH SHIELD OVER TRACE!

- RT. RANGE = 15 FT. LEFT = 15 FT.

4B: "RIGHT" DOME ON RT. CONTROLLER CHANGED.

→ SEL-RES. TRIGGERS ACCIDENTALLY WHEN FIRST IN PLASTIC (INTERMIT) LEFT PLAYER W/ JOYSTICK RUNS TO LEFT IN REMOTE: CAUSED BY SHIELD TOUCHING PIN OF THE 74LS244

3B:

5B:

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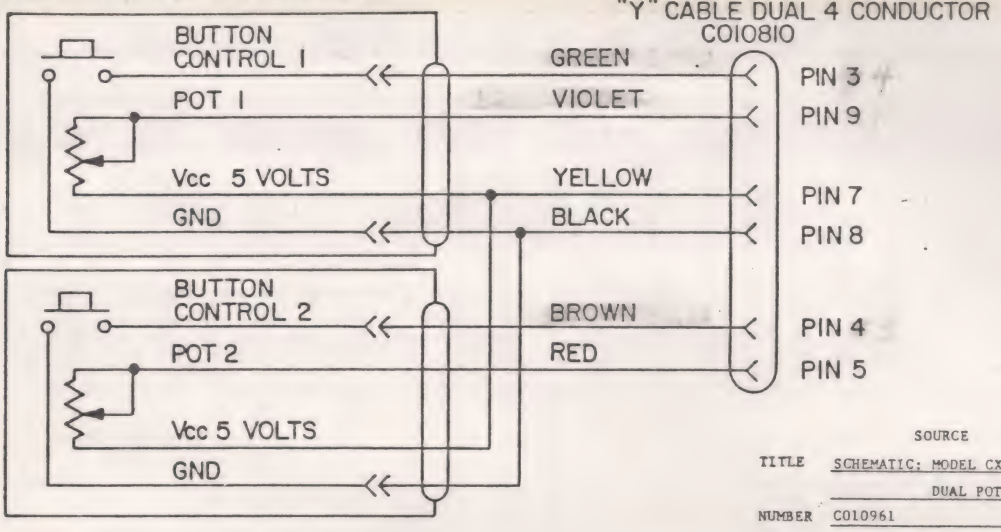
DUAL PADDLES



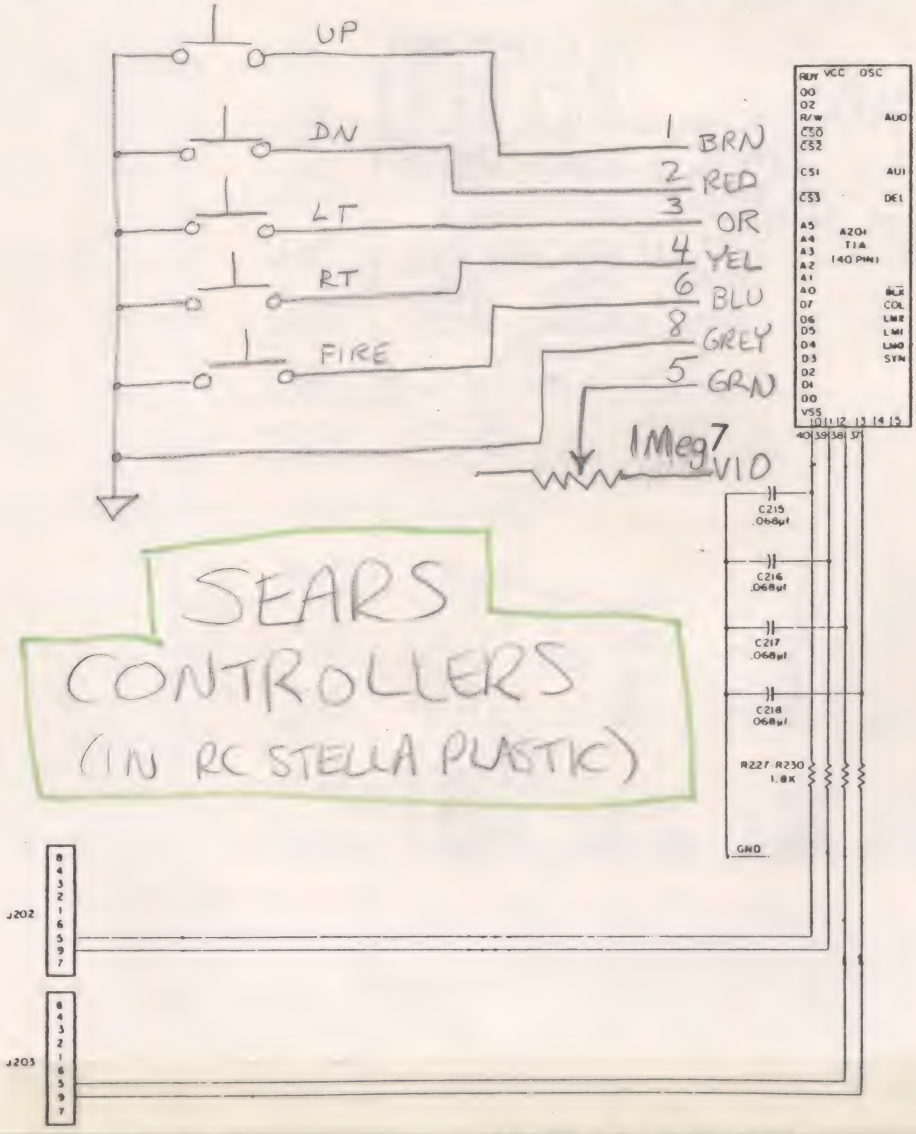
SOURCE

TITLE SCHEMATIC: MODEL CX-30
DUAL POT CONTROLLER

NUMBER C010961

REV A SHEET 1 OF 1

CINDY'S JOYSTICK + PADDLE COMBO



SEARS CONTROLLERS (IN RC STELLA PLASTIC)

WRITER DK	DATE 5/14	WITNESS	DATE

GAME OR PROJECT: CINDY

NOTED DISCREPANCIES:

→ JOYSTICK RT & LT LINES ON CONN ② WILL NOT GO ALL THE WAY TO A LOGIC LO - SIT AT +2V USING 74LS32, BUT WORKS W 7432 CHIP: LO SITS AT .5V TO .7V

→ IN COMBO MODE, [PADDLES ONLY IN THIS MODE?]
NO JOYSTICK LT-RT FOR EITHER CONTROLLER; PLAYER 1 MOVES RT. W/ COMBO 1 FIRE BUTTON, LT. W/ COMBO 2 FIRE BUTTON

CINDY

WRITER	DATE	WITNESS	DATE

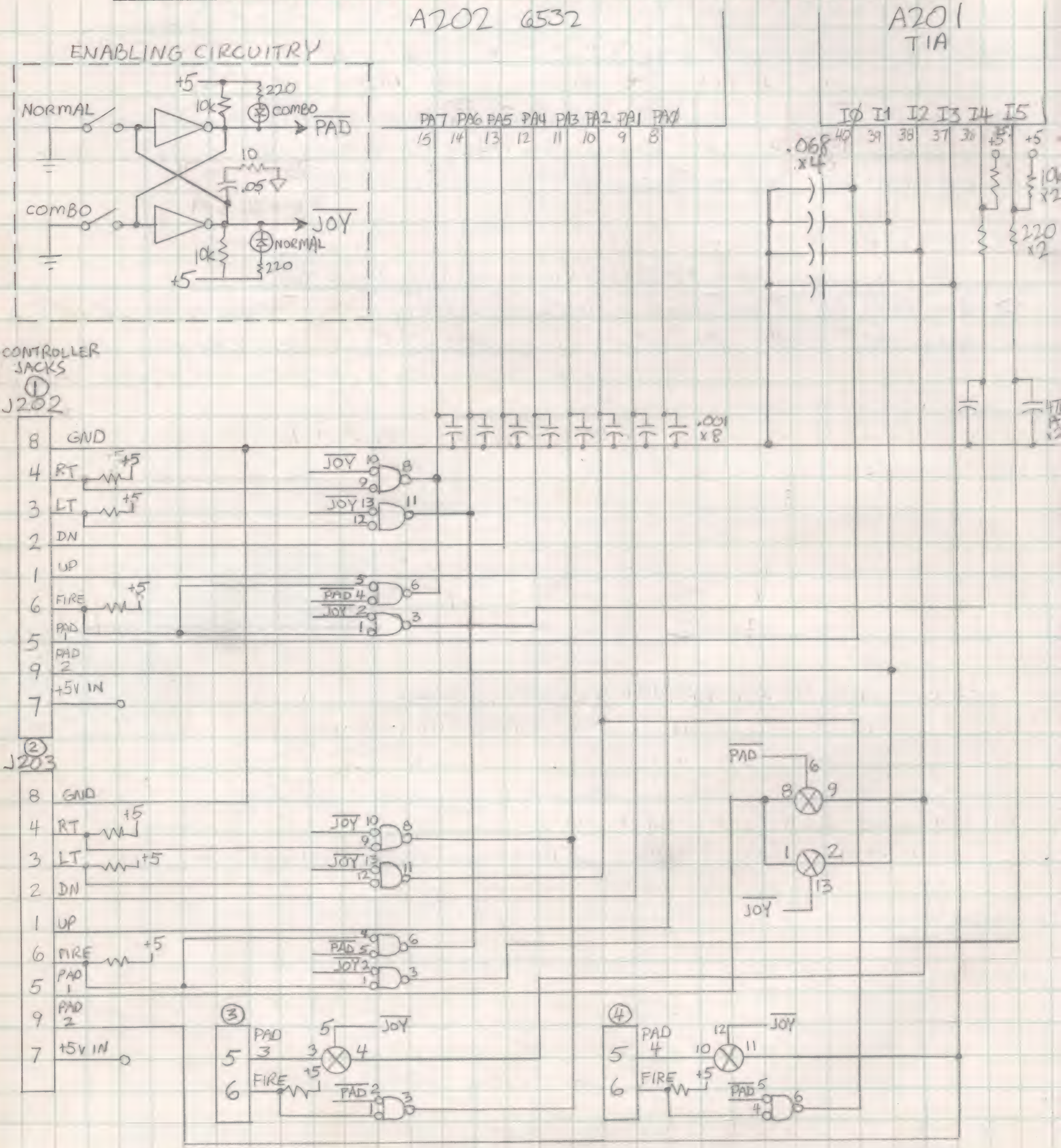
CINDY

28 JAN 15

ATARI® **ENGINEERING LOG SHEET**

GAME OR PROJECT

CINDY'S CONTROLLER SWITCHING CIRCUITRY #1



WRITER	DATE	WITNESS	DATE

GAME OR PROJECT

CONDUCTIVE RUBBER KEYPAD SWITCHES CHECKOUT

TYPE A: 1/8" DIA. GREY NIPPLE, TALL, W/ 3/16" BASE

	ON: MIN	MAX	TYP	OFF: MIN	MAX	TYP
#1	.5	2	1	1	5	2
#2	.5	2	1	1	4	1.5
#3	.5	1.5	1	1	3	1.5

[TIME IN mSec]

COMMENTS

TYPE B: 5/16" DIA GREY NIPPLE

	ON → MIN.	MAX.	TYP.	OFF → MIN	MAX	TYP.
#1	.5	1.5	<1	3	5	4
#2	<.5	<1	.5	2	>4	3

TYPE C: 1/4" DIA GREY NIPPLE

	ON → MIN.	MAX.	TYP.	OFF → MIN.	MAX.	TYP.
#1	.5	2	1	2	5	3
#2	.5	1.5	1	3	6	4

[NOT ENOUGH SNAP TO FINGER PRESSURE]

TYPE D: 3/8" DIA. BLACK KEYPAD, ROUND BUTTONS

	ON → MIN.	MAX.	TYP.	OFF → MIN.	MAX	TYP.
#1	1.5	3	2	2	4	3

TYPE E: BROWN CALC. KEYPAD, RECT. BUTTONS

ON → MIN.	MAX.	TYP.	OFF → MIN.	MAX.	TYP
.5	2	<1	2	4	3

NOTE:
DIFFICULTY IN OBTAINING CLEAN RESPONSES WHEN RUBBER SURROUNDING SWITCHES WAS NOT STAYING FLAT ON UNDERLYING SURFACE

TYPE F: 3/16" GREY NIPPLE w/ 1/2" BASE

ON → MIN.	MAX.	TYP.	OFF → MIN.	MAX.	TYP.
.5	2	1	1.5	4	2

TYPE G: 1/8" GREY NIPPLE, SHORT, W/ 3/16" BASE

ON → MIN	MAX	TYP	OFF → MIN.	MAX.	TYP.
.25	1	.5	.75	2	1

TYPE H: 3/16" GREY NIPPLE, 5/16" BASE

ON → MIN	MAX	TYP	OFF → MIN	MAX	TYP.
.2	1	.5	.5	2	1

WRITER	DATE	WITNESS	DATE
DK	7/14		

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT

CONDUCTIVE RUBBER KEYPAD SWITCHES CHECKOUT

TYPE I: 5/16" GREY NIPPLE, 7/16" BASE

	ON → MIN	MAX	TYP.	OFF → MIN	MAX	TYP.
	.5	1	.75	1.5	4	2.5

TYPE J: 3/16" GREY NIPPLE, 5/16" BASE

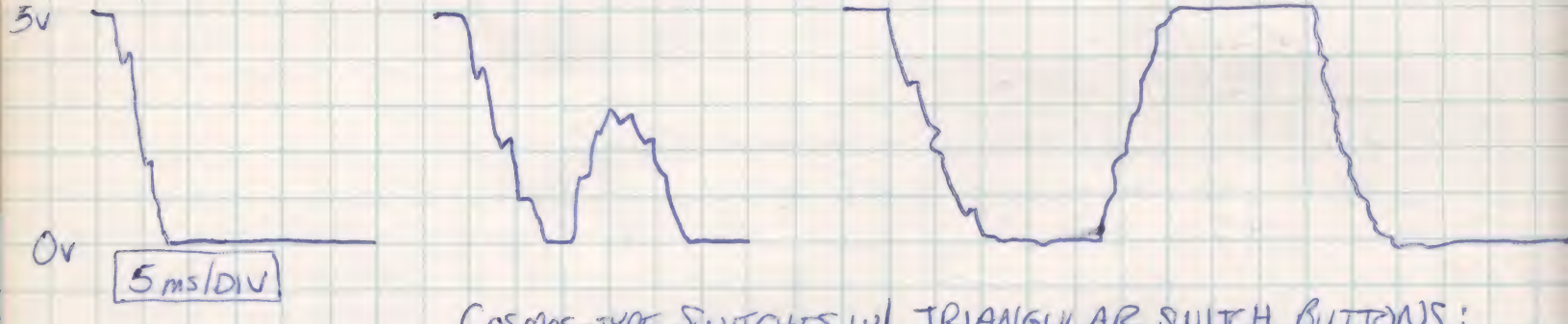
	ON → MIN	MAX	TYP	OFF → MIN	MAX	TYP.
	.2	.75	.4	.5	1.5	1

NOISY OFF

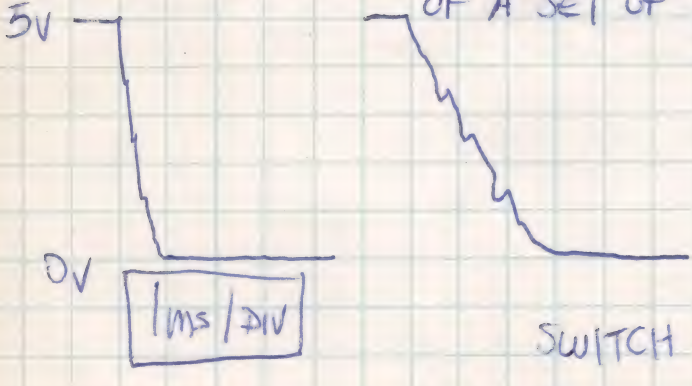
TYPE K: 3/16" GREY NIPPLE, 5/16" BASE

	ON → MIN	MAX	TYP	OFF → MIN	MAX	TYP
	.2			.5	1.5	1

TYPICAL WAVEFORMS



COSMOS-TYPE SWITCHES W/ TRIANGULAR SWITCH BUTTONS: COMMON PROBLEM IS NON-VERTICAL TRAVEL OF BUTTON, WHICH CAUSES BOUNCE. THIS TYPE OF SWITCH ARRANGEMENT WAS NOT AS FAST & CLEAN AS OTHER SWITCHES TESTED WHICH WERE JUST HELD DOWN ON TOP OF A SET OF CONDUCTOR PADS & THEN DEPRESSED:



SWITCH TYPES A-K

WRITER DK	DATE 7/15	WITNESS	DATE

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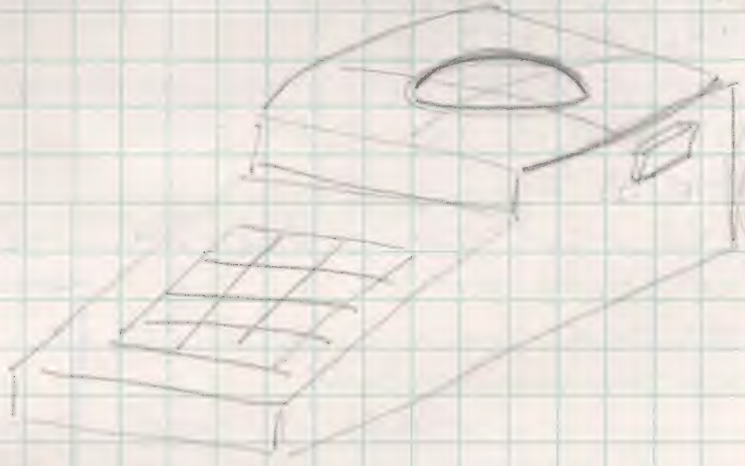
GAME OR PROJECT Trak-Ball

ALTERNATE HOUSING STYLES:

① HAND-HELD RECT. W/ KEYPAD STEPPED DOWN



②

SPACE NEEDLE

WRITER	DATE	WITNESS	DATE

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT: 2600B STAR CHIP TESTING

#10339B: STELLETTE
#10338B: STAR 'B'

CHIP#	SYMPTOMS & COMMENTS
STELLETTE 1	COLOR, BUT NO SOUND. NO ADDRESSES OR DATA FROM 6532
" 2	" " " " "
" 3	COLOR, NO SOUND. RESET INCOMPLETE, 6532 LINES INCOMPLETE
" 4	SAME AS 1 & 2
" 5	COLOR, NO SOUND. LINE THRU LUMINANCE PICTURE
STAR B 1	NO COLOR, NO SOUND, NO SYNC
STAR B 2	SAME AS 11
STAR B 3	SOUND, BUT NO COLOR - LOSES SYNC SOMETIMES
STAR A 4	EVERYTHING LOOKS OK
STAR B 5	SAME AS 11
STAR A 10	EVERYTHING LOOKS OK
	STAR 'B' CHIPS
16	NOTHING IN ORDER - NO SYNC, ETC.
17	SAME AS 16
18	SOMEWHAT SYNCED, NO SOUND
19	MARGINAL COLOR, SOUND OK
20	OUT TO LUNCH! - NO VIDEO
21	SAME AS 16
22	SAME AS 19
23	SIGNAL NOT SYNCED, BUT NOT IDENTICAL TO 16
24	SAME AS 16
25	MARGINAL SYNC, NO SOUND, ~~MARG~~ NO COLOR LOCK
26	NOTHING RIGHT
27	MARGINAL COLOR, NOISY SYNC, SOUND UNDERWATER
28	TERRIBLE SYNC & COLOR, NO SOUND
29	NO COLOR (NOISY), SOUND OK
30	NO COLOR LOCK, NO SYNC
31	NO COLOR OR SYNC
32	GOOD SOUND & SYNC, COLOR STILL AFU
33	SAME AS 24

STAR CHIP PINOUTS INCORRECTLY NOTED FOR PINS 5-6 CAPACITORS TO GROUND: S/B 20 pf ON PIN 6 (INPUT) AND 47 pf ON PIN 5 (OUTPUT)

WRITER	DATE	WITNESS	DATE
DK	7/21		

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ENGINEERING LOG SHEET

GAME OR PROJECT

2600 B STAR CHIP TESTING

*GIVEN TO DAVE PINA FOR LSI TESTING W/ 2600 B PCB

CHIP#	SYMPTOMS / COMMENTS			
	COLOR OK	SOUND OK	OTHER OK	PROBLEMS
34	X	X	X	
35	X		X	
36				
37	X		X	ONE TONE MISSING ON SOUND
38	X		X	SOUND IN VIDEO (GARBAGE)
39	X	X	X	
40				
*41	X	X	X	
*42	X		X	SOUND IN VIDEO (AUDIBLE)
*43	X	X	X	
44				
*45	X	X	X	
*46	X		X	SOUND IN VIDEO (AUDIBLE)
47				ALL FEATURES AFU
48	X		X	SOUND IN VIDEO (AUDIBLE)
49	X		X	" " "
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65				

WRITER	DK	DATE	7/27	WITNESS		DATE	

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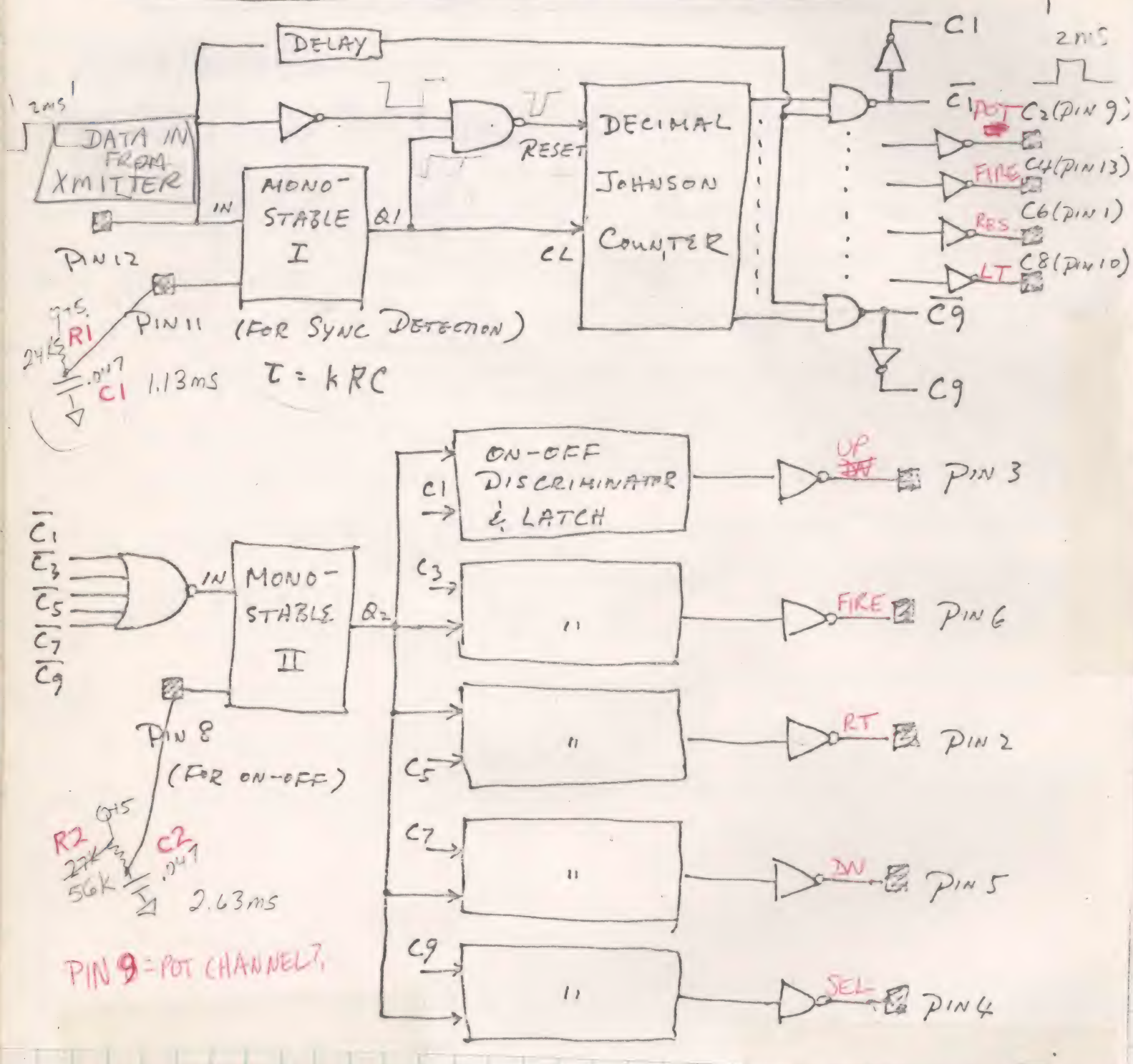
SIMPLIFIED CIRCUIT SCHEMATIC OF CIC006



R1 = 23.9k
C1 = .0465 μf
R2 = 55.6k
C2 = .0474 μf

w/ R200 @ 25k, SYNC WIDTH ≈ 1.6msec

WRITER	DATE	WITNESS	DATE

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ENGINEERING LOG SHEET

GAME OR PROJECT

CIC006 DECODER TESTING

OBJECTIVE: Determine Sync Detect one-shot timing limits RC components measured to 1%, varying Xmitter-produced sync width with R200

PROCEDURE: Increase input pulse width to hit threshold for Johnson Counter. Should be approx. 500 μsec. Also, do the same for the Hi-Lo detector.

CHIP#	J.C.	Hi-Lo	SYNC: ON-TIME	OFF-TIME
1				
2				
3				
4				
5				
6				
7				
8				
9				

WRITER	DATE	WITNESS	DATE
DK	8/10		

ATARI® **ENGINEERING LOG SHEET**

GAME OR PROJECT: RC STELLA SYNC TESTING

RECEIVER SYNC PROCESSING MODIFICATION

TESTED PARTS CODED WITH → (green)

L XMITTER SYNC PULSE OUTPUT = 550 μsec WIDTH

	BEFORE MOD	AFTER
L RECEIVER #1 =	350 μsec	480 μsec
" #2 =	330	450
" #3 =	340	480
#4 =	325	440

MODIFICATION:
REMOVE R227, 18k
" R234, 68k
" C213, .005μf
REDUCE C214, 1μf, to .1μf

R XMITTER SYNC PULSE OUTPUT = 450 μsec WIDTH

	BEFORE MOD	AFTER
R RECEIVER #1 =	225 μsec	360 μsec
" #2 =	180	340
" #3 =	270	410
#4 =	300	440

.45
1.0 ON
2.0 OFF

JOE FERNANDEZ' FCC UNIT:

L XMITTER SYNC OUT = 610 μsec
L RECEIVER SYNC OUT = 450
R XMITTER SYNC OUT = 600
R RECEIVER SYNC OUT = 420

WRITER DK	DATE 8/12	WITNESS	DATE

ATARI **ENGINEERING LOG SHEET**

GAME OR PROJECT

RC STELLA SYNC TESTING

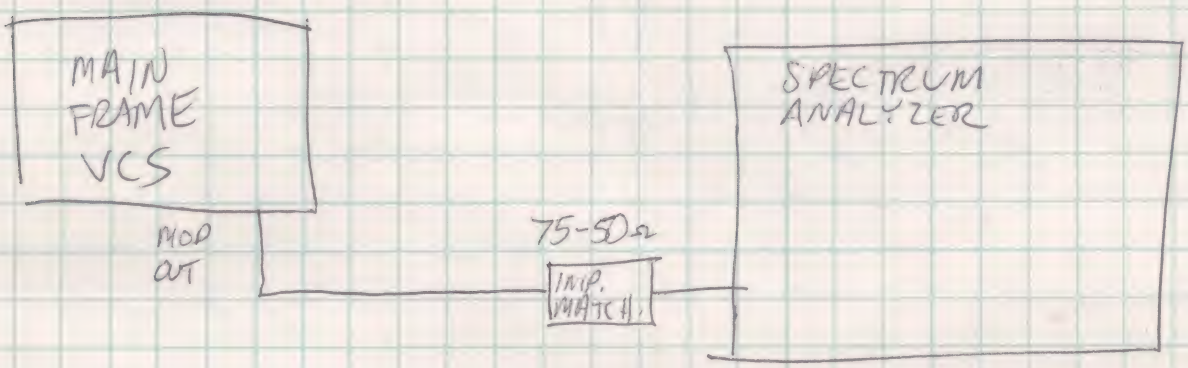
TRANSMITTER SYNC & PULSE GENERATION

USE XMITTERS W/ FOLLOWING COMPONENT VALUES ; R203 = 22k ±1%
R200 = 5.6k ±1%
R201 = 10k ±1%
C202 = .047μf ±1%

	SYNC	RT (OFF)	RT (ON)
L1	.500	2.20	.80
R1	.500	2.25	.85
L2	.500	2.25	.85
R2	.500	2.20	.80
L3	.480	2.25	.85
R3	.500	2.25	.85
L4	.460	2.20	.75
R4	.500	2.25	.80

REC: SYNC .440 | RT OFF .400 | RT ON .72 | 2.1

VCS MODULATOR ADJUSTMENT



1. SET RES. BW TO 300kHz (ISOLATES FREQ. OF INPUT)
2. SET VIDEO BW TO 300kHz (ISOLATES VIDEO BW)
3. SET SPAN (FREQ./DIV) TO 10MHz TO SHOW ENTIRE FREQ. SPAN (CH 2 = 55MHz)
4. SET CENTER FREQ. TO 61.75MHz FOR FCC, 61.25 FOR PRODUCTION (CH. 3) ±300kHz
5. ADJ. MOD TO CENTER OUTPUT FREQ. @ 61.75MHz (±50kHz)
6. LOOK AT CH. 2 FREQ. WHEN 3 IS SET, S/B WITHIN 300kHz

WRITER	DATE	WITNESS	DATE

ATARI® **ENGINEERING LOG SHEET**

GAME OR PROJECT 2600A JAILHOUSE EFFECT INVESTIGATION
CRUPP'S CONTROLLER SOFTCHANG CIRCUIT BD

INTENTION: ISOLATE LUM 1 LINE (PIN 5 ON TIA) FROM PROXIMITY TO PIN 4 (Ø2). CONTINUE PROCESS IN STEPS UNTIL AN IMPROVEMENT IS NOTED

STEP 1: CUT PIN 5 TRACE, LIFT TIA LEG & RUN WIRE TO R219 FOR OUTPUT. NO CHANGE

STEP 2: CUT END OF PIN 5 TRACE AT R219, 3300 Ω. NO CHANGE

STEP 3: LIFT R219, USE FLOATING 3300 Ω RESISTOR TO +5V. NO CHANGE

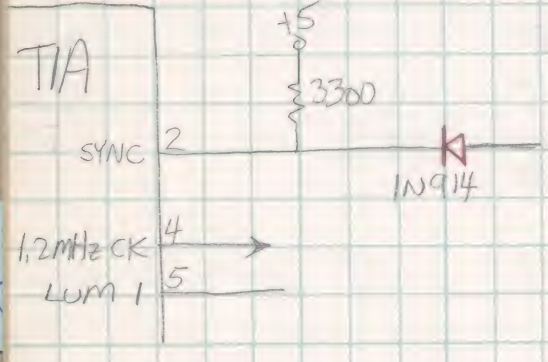
STEP 4: TRY CLEAN +5V SUPPLY ON MODULATOR FOR R219. NO CHANGE

STEP 5: LIFT R215, USE FLOATING 56k RESISTOR. NO CHANGE

STEP 6: CONNECT FLOATING R215 DIRECTLY TO MODULATOR. NO CHANGE

STEP 7: ABANDON - NO OVERALL IMPROVEMENT

NEW IDEA



WRITER DK	DATE 9/14	WITNESS	DATE

ATARI

ENGINEERING LOG SHEET

GAME OR PROJECT

CINO4 - NEW LOGIC BREADBOARD BUGS

(1) 74LS157 MULTIPLEXER NEEDS JOYSTICK ACTIVE LO ON PIN 1 TO ACTIVATE - CHANGE SCHEMATIC FROM PADDLE ACTIVE LO

WRITER	DATE	WITNESS	DATE

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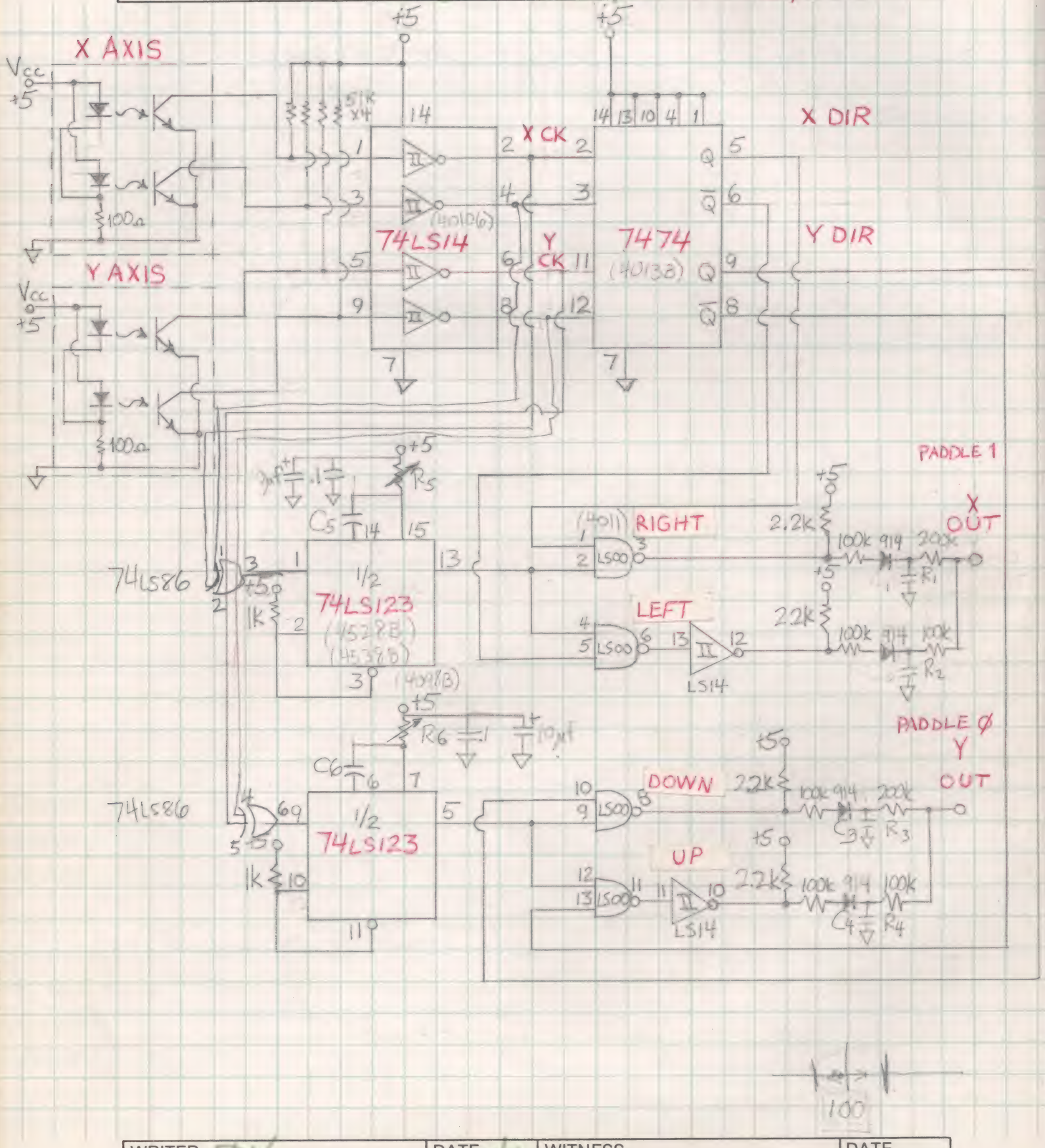
ENGINEERING LOG SHEET

GAME OR PROJECT: ANALOG TRAKBALL (TTL)



WRITER	DATE	WITNESS	DATE
DK	9/14		

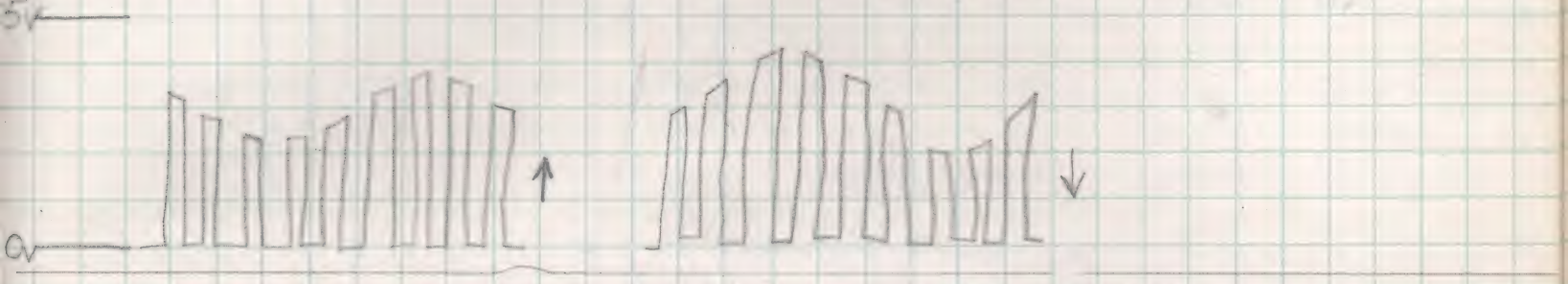
GAME OR PROJECT: ANALOG TRAK-BALL

LEFT & UP HAVE POOR LO-MOTION RESOLUTION 'SOFTWARE OR HARDWARE?
↖ POOR DIRECTION CHANGES w/ DIFF. BOOT-UPS OF PROGRAM.

WAVEFORMS:

LT & UP

RT. & DN.



CONTROLLED FREQ. INPUT TEST #1

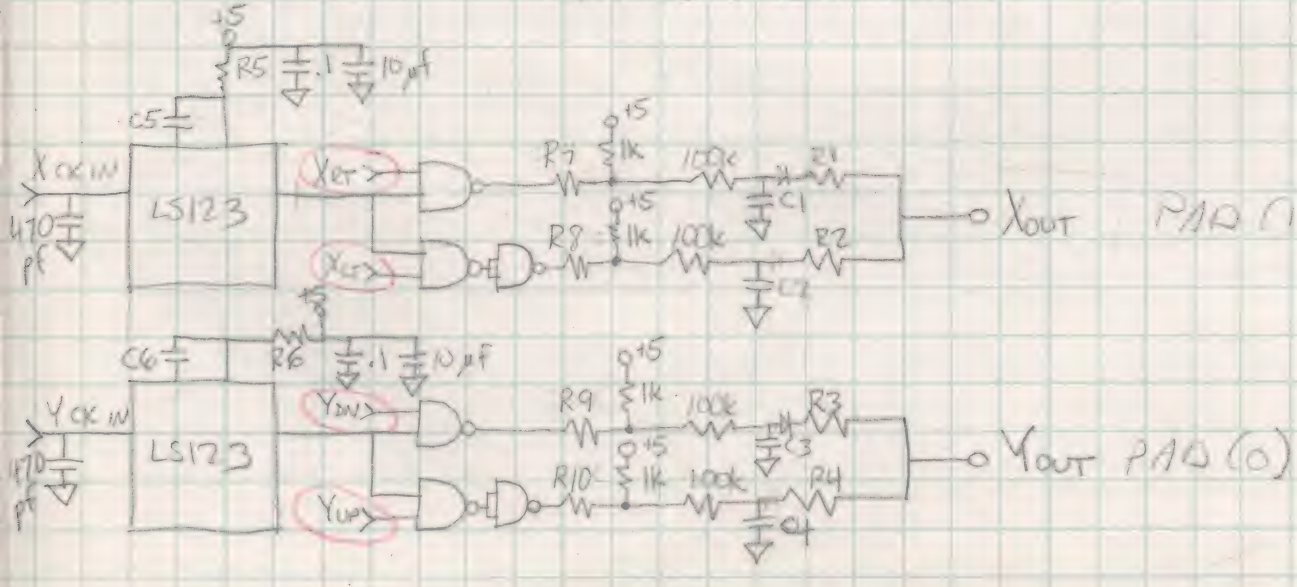
C1-C4 = .47μf
R1-R4 = 470k
C5 & C6 = .47μf
R5 & R6 = 62k
X ONE-SHOT: 9msec OUT
Y ONE-SHOT: 9msec OUT
R7-R10 = 4.7k

X-Y PROGRAM:
```
10 ?PADDLE(1),PADDLE(0)
20 GOTO 10
```
[PADDLE(1)=X, PADDLE(0)=Y]

f_{IN} = Ø Hz (STATIC): X = 136 Y = 147

	ΔX_{RT}	ΔX_{LT}	ΔY_{UP}	ΔY_{DN}
f_{IN} = 50 Hz:	+9	-9	-9	+10
100 Hz:	+19	-16	-17	+21
150 Hz:	ONE-SHOT SATURATED			

CKT. CONFIGURATION



WRITER	DATE	WITNESS	DATE
DK	9/15		

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT: ANALOG TRAK-BALL

CONTROLLED FREQ. INPUT TEST #2

C1-C4 = .47μf
R1-R4 = 470k
C5 & C6 = .2μf
R5 & R6 = 62k
R7-R10 = 2.2k
X ONE-SHOT = 4 msec
Y ONE-SHOT = 4msec

f_{IN} = Ø Hz (STATIC) X = 152 Y = 166

	ΔX RT	ΔX LT	ΔY UP	ΔY DN
f_{IN} = 50 Hz:	+9	-8	-8	+9
100 :	+19	-15	-17	+22
150 :	+30	-21	-22	+38
200 :	+44	-28	-31	+42

f_{MAX} = 250

TEST #3: OUTPUT RESISTORS READJUSTED TO GIVE MORE EQUAL CHANGES AT HIGHER FREQUENCIES

ALL VALUES SAME EXCEPT:
R1 = 220k
R4 = 220k

f_{IN} = Ø Hz (STATIC) X = 114 Y = 125

	ΔX RT	ΔX LT	ΔY UP	ΔY DN
f_{IN} = 50 Hz:	+6	-8	-9	+7
100 :	+12	-16	-17	+13
150 :	+19	-23	-25	+21
(f_{max} = 250) 200 :	+27	-29	-31	+30

TEST #4: OUTPUT RESISTORS OPTIMIZED FOR EQUAL CURSOR TRAVEL ON BOTH X & Y AXES ON TV SCREEN.

C1-C4 = .1μf
R1 = 360k R2 = 220k
R3 = 360k R4 = 220k
C5 & C6 = .15μf
R5 & R6 = 62k
R7-R10 = 2.2k
X ONE-SHOT = 3msec
Y ONE-SHOT = 3msec

f_{IN} = Ø Hz (STATIC) X = 103 Y = 123

NOTE: FREQ. BEATING ON LAMP REQUIRED THESE FIXES FOR STABILITY:

	ΔX RT	ΔX LT	ΔY UP	ΔY DN
f_{IN} = 60 Hz:	+5	-6	-8	+6
90 :	+8	-9	-11	+10
120 :	+10	-13	-15	+13
150 :	+14	-14	-18	+17
200 :	+20	-19	-23	+23
250 :	+22	-21	-25	+27
300 :	+28	-24	-29	+33

f_{max} = 330

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DK	9/23		

GAME OR PROJECT

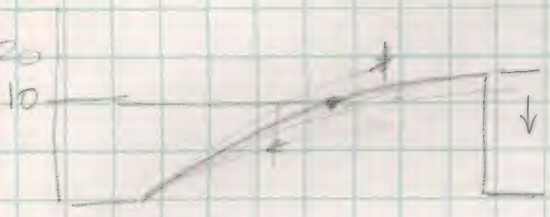
ANALOG TRAK-BALL

TEST #5 : SAME AS #4 EXCEPT IN914 DIODES INSERTED FOR RT & DN BEFORE R1 & R3

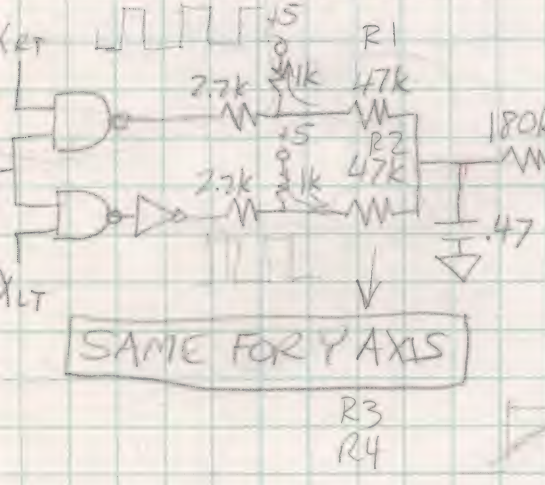
f_{IN} = ØHz (STATIC) X = 110 Y = 121

	ΔX_{RT}	ΔX_{LT}	ΔY_{UP}	ΔY_{DN}
f_{IN} = 60Hz :	+6	-7	-8	+6
90 :	+8	-10	-10	+10
120 :	+13	-14	-15	+14
150 :	+16	-17	-19	+18
200 :	+22	-21	-24	+25
250 :	+31	-26	-28	+33
300 :	+38	-29	-32	+42

fmax = 330Hz



TEST #6 : SAME CIRCUIT OUT TO VOLTAGE DIVIDERS ON GATED DRIVE OUTPUTS



f_{IN} = ØHz (STATIC) X = 108 Y = 116

	ΔX_{RT}	ΔX_{LT}	ΔY_{UP}	ΔY_{DN}
f = 60Hz :	+6	-5	-6	+6
90 :	+9	-7	-8	+9
120 :	+12	-10	-11	+13
150 :	+16	-12	-13	+16
200 :	+22	-15	-17	+23
250 :	+29	-18	-20	+31
300 :	+37	-21	-24	+39

TEST #7 :

SAME AS ABOVE EXCEPT:

R1 = 43k RT
R2 = 30k LT
R3 = 47k DN
R4 = 36k UP

ADJUSTED FOR $\Delta X_{RT} = \Delta X_{LT}$ @ 200Hz
$\Delta Y_{UP} = \Delta Y_{DN}$ @ 200Hz

f_{IN} = ØHz (STATIC) X = 111 Y = 120

	ΔX_{RT}	ΔX_{LT}	ΔY_{UP}	ΔY_{DN}
f = 60Hz :	+5	-7	-7	+6
90 :	+7	-9	-10	+9
120 :	+11	-12	-13	+12
150 :	+14	-14	-16	+16
200 :	+19	-19	-22	+21
250 :	+24	-22	-24	+29
300 :	+30	-26	-28	+37

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DK	10/8		

88-102-121 84-110-131 87-102-134 (350)

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GAME OR PROJECT: ANALOG TRAK-BALL

TEST #8

SAME AS #6, EXCEPT:
RT R1 = 43k
LT R2 = 30k
DN R3 = 43k
UP R4 = 30k

f_{IN} = 0 Hz (STATIC) X = 110 Y = 120

	ΔX_{RT}	ΔX_{LT}	ΔY_{UP}	ΔY_{DN}
f = 60 Hz:	+7	-5	-5	+4
90 :	+10	-8	-8	+10
120 :	+12	-10	-12	+13
150 :	+14	-13	-15	+16
200 :	+19	-18	-20	+20
250 :	+23	-23	-27	+25
300 :	+26	-29	-34	+29

TEST #9: NEW BREADBOARD – SAME COMPONENT VALUES FOR R1-R4, ETC.

$X_{ONE-SHOT}$ = 2.2 msec
$Y_{ONE-SHOT}$ = 3.0 msec

SPOT-CHECK FOR EQUALITY

f_{IN} = Ø Hz X = 109 Y = 118

	ΔX_{RT}	ΔX_{LT}	ΔY_{UP}	ΔY_{DN}
f = 120 Hz	+9	-9	-12	+11
250 Hz	+18	-17	-23	+24

TEST #10: N.B-BD, SAME AS ABOVE EXCEPT X ONE-SHOT (R5) ADJUSTED TO GIVE 3.0 msec OUTPUT PULSE...

OBSERVATIONS:

HI-SPEED ACCELERATION MAXES OUT TOO SOON: HAVE TO INCREASE TOP SPEED FREQ. LIMIT / REDUCE ONE-SHOT PULSE WIDTH, INCREASE CURRENT DRIVE FROM 5V LINE)

f_{IN} = Ø Hz X = 109 Y = 119

	ΔX_{RT}	ΔX_{LT}	ΔY_{UP}	ΔY_{DN}
f = 60 Hz:	+5	-6	-7	+5
90 :	+7	-9	-9	+8
120 :	+10	-12	-12	+11
150 :	+13	-14	-15	+14
200 :	+18	-18	-20	+19
250 :	+23	-22	-24	+25
300 :	+28	-25	-27	+31

Q - IS VELOCITY VS FREQ. LINEAR?

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JK	10/8/81		

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ENGINEERING LOG SHEET

GAME OR PROJECT: PAM MEETING, THE WHOLE GANG

PRELIM. RELEASE IN FEB. (PARTS, DOCUMENTATION)
C.E.S. FACSIMILE FOR JAN. (2nd wk.), HOG-OUT PLASTIC, 8-12 UNITS?
SOFT-TOOLED PLASTIC IN MARCH.
CARTRIDGE DESIGN IN MID-LATE OCTOBER

TRAK BALL OPTIONS: LO-COST, LO-PERFORMANCE
HI-COST, SUPERIOR PERF. TO ANALOG JOYSTICK
CAN'T REDUCE BALL SIZE & MAINTAIN SUPERIORITY OF PERFORMANCE
WILL KEY PAD GO ABOVE, OR BE BOTH ON L&R SIDES? (2 PER UNIT)

WRITER	DK	DATE	10/1	WITNESS		DATE	

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT: TRAK-BALL RAP SHEET

CONSIDERATIONS FOR OPTIMUM PERFORMANCE

The Ball:

→ Reduction in ball size degrades performance
→ Reduction of ball gravity " "
→

The Roller Assembly:

→ Bearings must be good enough to allow ball momentum to carry itself after removal of hand energy
→ Rollers must be horizontal to ground (level)
→ Rollers must be hard steel to prevent groove formations

Cursor Movement:

→ Equal travel L TO R & UP TO DN for all speeds
→ Quick acceleration to max frequency
→ Smooth resolution on vernier adjustments - good instantaneous response for small ball movements.

WRITER	DATE	WITNESS	DATE

ATARI® ENGINEERING LOG SHEET

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GAME OR PROJECT: TRAKBALL RAP SHEET

CONSIDERATIONS FOR TRAKBALL OVER JOYSTICK (OR IN ADDITION TO)

→ Closer approximation to arcade video play at home

→ Greater amount of control w/ better feel to the response (increased fluidity of cursor motion)

→ Alternative to grasping-type stick control (palm & fingers)

→ Long-term wear probably better, less breakage

→ Variation in speed control superior to one-speed joystick (switch), also more easily controlled than absolute position (analog joystick)

→ No mechanical slop causing hysteresis or dead zone in response

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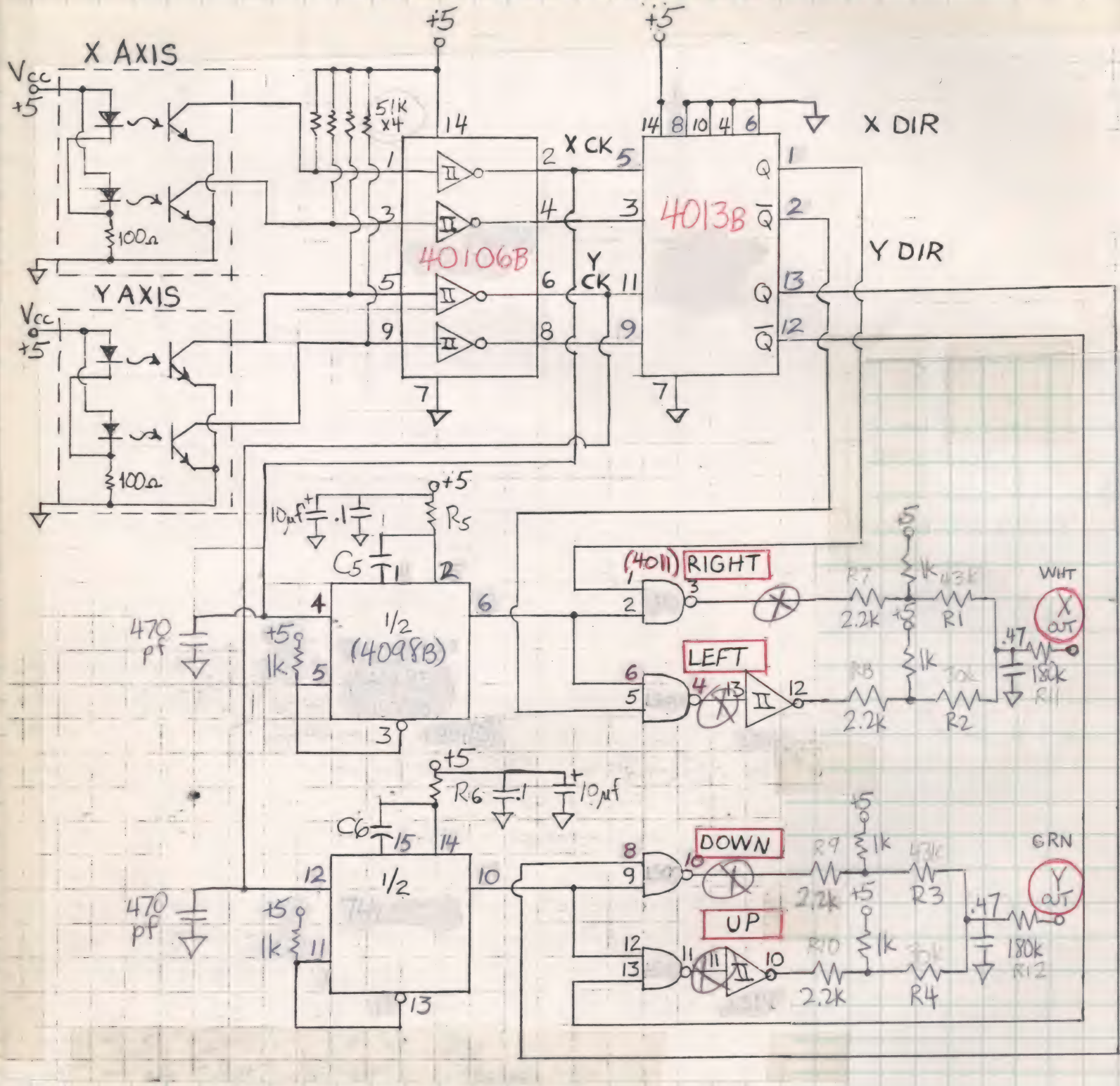
GAME OR PROJECT

ANALOG TRAKBALL (CMOS)



Ⓧ = VCS CONTROL LINE OUTPUTS

WRITER	DATE	WITNESS	DATE
DK	10/20/81		

GAME OR PROJECT
TRAKBALL : SIMULATED INPUT ON POT LINE TO POKEY

TEST SITUATION: 250k TO +5v RUN INTO ADT LINE : PADDLE # 107

PAM CONTROLLER PIN DESIGNATIONS

PIN #	COLOR WIRE	DESIGNATION
1	BLUE	COL STB 2
2	WHITE	COL STB 1
3	GREEN	COL STB Ø
4	VIOLET	COL STB 3
5	ORANGE	ROW DATA 2
6	RED	ROW DATA 1
7	BROWN	ROW DATA Ø
8	YELLOW	ROW DATA 3
9		S2 (TRAKBALL CLR LINE) / REG. POT V+
10		POT Ø
11		POT 1
12		+5V TRAKBALL SUPPLY
13		TRIGGER
14		SF (FIRE #2)
15		GND

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GAME OR PROJECT

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PCB SUB-ASSY PARTS LIST CA018030
SCHEMATIC, STUFF DIA, PCB ASSY PARTS LIST CA018029
PCB CO18028

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GAME OR PROJECT: CINDY 1ST ARTICLE

(1) CHANGE QTY. ITEM 27, 10kΩ, FROM 12 TO 14 (ON PARTS LIST).

(2) ON STUFF DIA: C25 + ON WRONG LEAD, C14 + LEAD 1 SON RT.

(3) PADS FOR L.E.D.'S ON CIRCUIT SIDE ARE NON-EXISTENT: THEY MAY HAVE BEEN PUT DOWN AS FEED-THRU HOLES.

(4) CIRCUIT-SIDE TRACES WHICH RUN OVER GND. PLANE FOR RF MOD. HAVE STRIPS OF TRACE BETWEEN THEM WHICH MAY HAVE BEEN INTENDED TO CONTINUE GROUND, BUT DO NOT. SHOULD BE ELIMINATED BECAUSE THEY CREATE CAPACITIVE COUPLING BETWEEN TRACES.

(5) U6 PINS 8 & 9 ARE REVERSED

(6) CONNECTIONS REVERSED FOR WIPER & UNGROUNDED SIDE OF R7, THE 500K POT.

(7) GAME STARTS UP IN "A DIFFICULTY," BOTH SIDES - SHOULD START IN "B"
→ R31-C33 NETWORK SHOULD BE CONNECTED TO S7, RIGHT B SWITCH
→ R26-C32 NETWORK SHOULD BE CONNECTED TO S8, LEFT B SWITCH

(8) PAD FOR GND CONNECTION OF C29 RADIAL LEAD NOT GROUNDED.

(9) .22 μf DECOUPLING NEEDED ON +5V TRACE AT RIGHT END OF TIA (U2)

(10) NEED GND. CONNECTED FROM SHIELD TO MODULATOR GND. PLANE IN A MORE DIRECT FASHION; ALSO, BEEF UP GND. AROUND MODULATOR WHEREVER POSSIBLE.

(11) MOVE C22 INTO OPEN AIR, AWAY FROM HEATSINK

CINDY

WRITER	DATE	WITNESS	DATE
DK	10/27		

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT: 2600 Ram Test

1) WITH STOCK 2600 VCS:

a) CHECK SIG. ROMS #11-20 FOR FAILURES & BUGS

11 EARLY FAIL - NOT TESTED BY ME
12 POWER UP LOST UNTIL WARM } NOT EASILY REPEATED
13 "
14 "
15 NO BUGS APPARENT
16 NO BUGS APPARENT
17 CHARACTERS IN WRONG PLACE TO START; BLACK SCREEN A COUPLE OF TIMES
18 PICTURE BOMBED IN MID GAME
19 NO BUGS APPARENT
20 NO BUG APPARENT

b) NEW-TYPE SIG. ROMS #1-10, SAME CHECK:

1 } NOT TESTED
2 }
3 }
4 OK
5 OK
6 OK
7 OK
8 OK
9 OK
10 OK

c) OK! ROMS #M220-M230

220 OK
221
222 OK
223
224 ONE LOCKUP - 2 / ONE OK
225 OK
226-1 OK
226-2 LOCKUP ONCE
227
228 OK
229
230 OK

2) L200 DOUBLED TO 2 μH ON SAME 2600:

a) SIG. ROMS #1-10:

1 } NOT TESTED
2 }
3 }
4 OK
5 OK
6 OK
7 OK
8 OK
9 OK
10 OK

WRITER DK	DATE 11/80	WITNESS	DATE

GAME OR PROJECT

b) OKI Roms #M220-M230

220
222
224-1
224-2
224-3
225
226-1
226-2
226-3
228
230

NO DISCREPANCIES NOTED w/ SIG ROMS 1-10 OR OKI ROMS WHEN TESTED ON A STANDARD 2600A UNIT.

SIG. ROMS 17 & 18 EXHIBITED MORE NOTICEABLE FAILURE MODES WHEN TESTED ON THE 2600 WITH L200 @ 2 μH (REINFORCES THEORY OF INDUCTIVE EFFECT?)

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JK	11/24		

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GAME OR PROJECT: TRAKBALL PCB CHECKOUT

DISCREPANCIES:

1. MOUNTING HOLES NEED TO BE SPREAD - MOVE BOTTOM HOLE DOWN
2. LARGER HOLES FOR POTS
3. REMOVE EXTRA SM. PAD BY +5V PATCH-IN
4. SWITCH CONNECTIONS FOR 4500 PINS 5 & 6
5. MOVE 1K PULLUPS AT TOP CTR. OF PCB DOWN AS FAR AS POSSIBLE, SO AS TO PUT IN 2nd CABLE TIEWRAP (ADD HOLE LOCATION)
6. CONNECT PADS FOR 1K PULLUP & GRN. WIRE FROM RT. FIREBUTTON

PCB #1 LINEARITY CHECK

X & Y ONE-SHOTS = 2.0 msec

f_{in} = 0 Hz (STATIC) X = 110 Y = 117

	ΔX_{RT}	ΔX_{LT}	ΔY_{UP}	ΔY_{DN}
f = 60 Hz	+4	-4	+5	+5
120 Hz	+7	-8	-9	+7
250 "	+14	-14	-16	+15
350 "	+22	-21	-22	+22
450 "	+29	-25	-27	+31

WRITER	DK	DATE 11/25	WITNESS	DATE

ATARI **ENGINEERING LOG SHEET**

GAME OR PROJECT **CINDY** REV. 1 SCHEMATIC REVISIONS

SHEET 1

1. ADD "S" TO WORD "DIODE" ON NOTE 2C
2. LABEL POWER IN JACK 'J5'
3. CHANGE LED REF. DESIGNATIONS FROM DS TO CR
4. ADD '+' POLARITY SIGN TO UNGROUNDED SIDE OF C25
5. REVERSE PIN DESIGNATIONS FOR U6 PINS 8 & 9
6. MOVE R26-C32 NETWORK TO S3 FROM S2
   MOVE R31-C33 NETWORK TO S7 FROM S6
7. REDO "REFERENCE DESIGNATION BLOCK" TO ELIMINATE 'CR8-13' AND ADD (U) TO 'LAST USED'
8. ADD '5% 100V MYLAR' TO C22 REF. DES.
9. ADD PIN 6, NOTED 'N/C', ON TIA CHIP
10. FOR U2 PIN 11, CORRECT 'DSC' LABEL TO READ 'OSC'
11. SHOW CONNECTION FROM U3, PIN 22, GOING TO SHT. 2, LABELED (U)
12. LABEL LEFT A DIFF SWITCH 'S2', NOT 'S1'
13. CHANGE VALUE OF C3 FROM .1 μf TO .22 μf
14. NEXT TO CR10, RESISTOR IS R30, 220Ω

CIN

SHEET 2

1. ADD CIRCLES AROUND DIODE SYMBOLS FOR CR12 & CR13
2. CHANGE S4 LABEL FROM 'NORMAL SW.' TO 'JOYSTICK SW.'
   CHANGE CR13 LABEL FROM 'NORMAL LED' TO 'JOYSTICK LED'
3. CHANGE J1 PIN LABELS: PIN 1 SHOULD BE 'UP', NOT 'FORWARD'
   PIN 2 SHOULD BE 'DOWN', NOT 'BACK'
   PIN 8 SHOULD BE 'GND', NOT 'Ø VOLTS'
4. CHANGE VALUES IN SUMMING NETWORKS AS FOLLOWS:

	C10	R18	R19	R20	R21	R22	R23	R24
IS	100pf	2.7k	620Ω	13k	24k	56k	13k	10k
WAS	47pf	4.7k	1.2k	18k	36k	75k	18k	9.1k

5. SHOW CONNECTION FROM U6, PINS 11 & 12 (JOYSTICK ENABLE) TO SHT. 1, LABELED (U)

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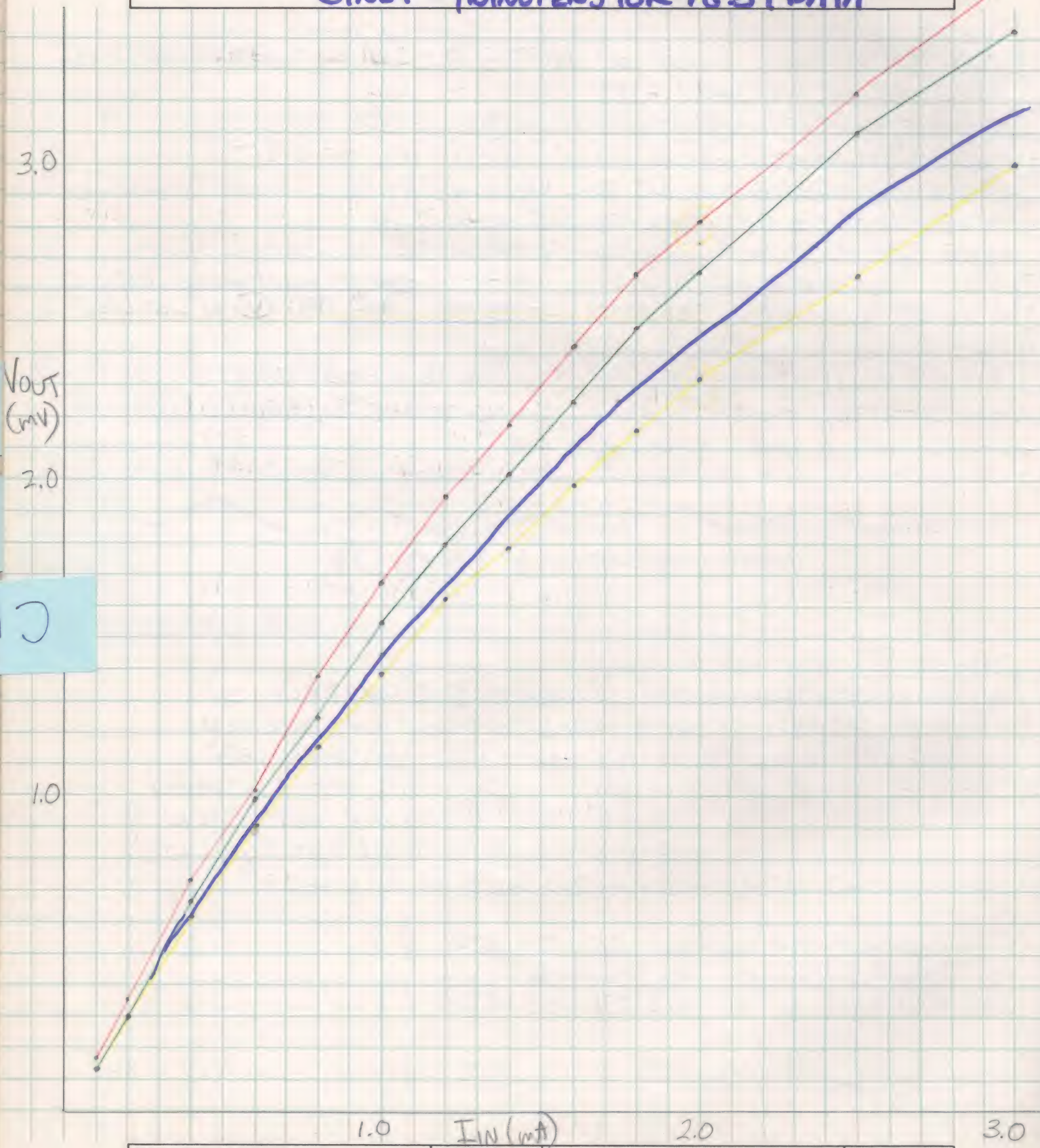
GAME OR PROJECT: CINDY : TRANSFERS FOR PG. 57 DATA

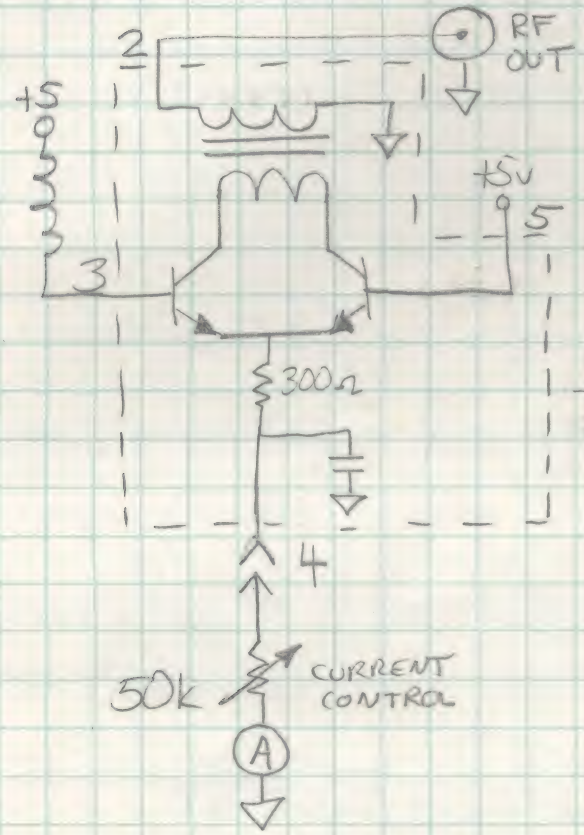


1J

WRITER	DATE	WITNESS	DATE

GAME OR PROJECT: CINDY: RF MOD CHARACTERIZATIONS

RF MOD



INITIAL SETUP XFER

(VOUT IS IN mV)

I_{IN}(mA) →	.1	.25	.50	1.0	1.5	2.0	2.5	3.0
#1	.190	.570	1.20	2.21	3.05	3.67	4.26	4.74

	#1	#2	#3	#4	#5 (A)*
.1	.127	.158	.130	.110	.125
.2	.295	.350	.300	.281	.291
.4	.665	.730	.610	.574	.622
.6	.990	1.05	.900	.860	.910
.8	1.25	1.38	1.16	1.10	1.17
1.0	1.55	1.68	1.39	1.38	1.44
1.2	1.80	1.95	1.62	1.58	1.67
1.4	2.02	2.18	1.79	1.79	1.86
1.6	2.25	2.42	1.99	1.99	2.05
1.8	2.48	2.65	2.16	2.18	2.29
2.0	2.66	2.82	2.31	2.34	2.45
2.5	3.10	3.23	2.65	2.71	2.78
3.0	3.42	3.62	3.01	3.03	3.09
3.5	3.70	3.98	3.27	3.30	3.30

CIN

#5A = RF MOD IN CKT. W/ STD VALUES IN SUMMING LINES: R214=27k R216=110k R215=47k R217=24k

HAD .880 mV OUT IN OPERATION

SOUND & COLOR BOTH 20-24dB down from VIDEO RF

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DK	12/2		

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ENGINEERING LOG SHEET

GAME OR PROJECT: CINDY: SIGNAL LEVEL MEASUREMENTS

LUMINANCE: STEPS (8) SHOULD BE EQUALLY SPACED AND COMPOSE 50% OF TOTAL SIGNAL LEVEL

SYNC: COMPOSES 25% OF TOTAL SIGNAL LEVEL UP TO WHITE LEVEL

CHROMA & AUDIO: BOTH LEVELS 24 dB down FROM RF OUTPUT LEVEL

R.F. OUTPUT LEVEL: NOMINAL OPERATIONAL OUTPUT: 1.3 TO 1.5mV

WRITER	DATE	WITNESS	DATE
DK	12/8		

ATARI® **ENGINEERING LOG SHEET**

GAME OR PROJECT

CINDY: REV.2 PCB FAB ROUGH-OUT CHEK

(1) BEEF UP +5VA TRACE UNDER XU2 AND ELSEWHERE (YELLOW TRACES)
(2) CREATE +5VB SUPPLY BY TAPPING A FERRITE BEAD OFF L7-C14 JUNCTION, WITH .01 uf CAP TO GND. ON OUTPUT. LOCATE IT BY C13-C15 NEAR MODULATOR (OUTSIDE SHIELD) AND RUN THE +5B BUSS THRU THE GAP IN SHIELD GND. BUSS TOGETHER THE 12 POINTS SHOWN IN YELLOW. COMPONENTS ARE: R9-R13, R54, R55, R16, R17, L2, C8, Q2 BASE.
(3) BYPASS ABOVE COMPONENTS WITH +5A BUSS
(4) ADD NEW LINE FROM U3 PIN 22, 18, OR 19 (WHICHEVER IS EASIEST) TO JOYSTICK ENABLE LINE (U7 PINS 5, 12 & 13 OR U6 PINS 11 & 12 OR U5 PINS 2 & 5) (PADS SHOWN IN YELLOW ALSO).
(5) ENLARGE GND TRACES UNDER SHIELD WHERE POSSIBLE (YELLOW TRACES)
(6) CONNECT UNGROUNDED SIDE OF C7 TO CR2-POT CONNECTION, NOT WIPER OF POT
(7) SEVER CONNECTION BETWEEN R28 & C32 (RIGHT END)
(8) RUN TRACE FROM C32 RT. END TO [redacted] C35 LT. END

REV. 2A PCB CHECKOUT 1ST ARTICLE

(1) ELIMINATE R28 PADS FROM PCB, TAKE OFF SILKSCREEN, ALSO C32 & C33
(2) CHANGE REF DES. FOR R28 TO R58 ON SCHEMATIC
(3) CHANGE REF. DES. DS8-13 TO CR8-13 ON SILKSCREEN
(4) ELIMINATE WAFFLED GROUND PLANE AROUND 2 HOLES FOR HEATSINK TABS - MUST BE SMOOTH GROUND PLANE FOR GOOD SOLDERING
(5) LEFT END OF R58 NOT GROUNDED
(6) CUT OFF CORNER OF PCB BY HEATSINK FOR AIR FLOW
(7) MOVE FEEDTHRU ABOVE MODULATOR PINOUT SECTION TO LEFT; THEN INCREASE WIDTH OF GROUND BUSS BETWEEN SHIELD & MODULATOR GROUNDS
(8) ADD MORE FEEDTHRUS TO GND. PLANE BETWEEN CONTROLLER PORTS - ONE IN BETWEEN EACH PAIR OF PORTS
(9) ADD FILLETS TO I.C. PADS, CART. SOCKET PADS

CINDY

WRITER DC EXT 5066	DATE 12/8	WITNESS	DATE

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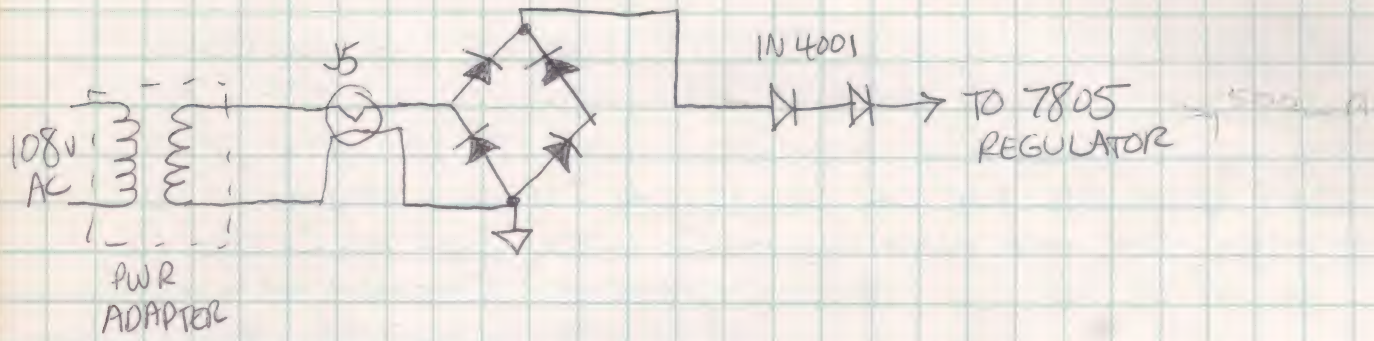
ENGINEERING LOG SHEET

GAME OR PROJECT: CINDY: VOLTAGE REGULATOR INPUT DIODES



WORST-CASE CONDITIONS:

① INPUT AC TO 108V, V_{OUT} OF BRIDGE = +9.1 VDC, +8.3V AFTER ONE DIODE, DOWN TO + V AFTER 2 DIODES.

② 7805 LOSES REGULATION WHEN INPUT GOES BELOW +6.5V DC

WRITER	DK	DATE	12/30	WITNESS		DATE	

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ENGINEERING LOG SHEET

GAME OR PROJECT: CINDY : SHOW UNIT CHECKOUT

1) MAJOR POINT : SPRING TENSION IN CONT ROLLERS FIRE BUTTON
   a) W/ NO SPRING AT ALL : GOOD, BUT COULD STILL BE BETTER
   b) CHANGE ANGLE OF RAMP IN PLASTIC, DO W/OUT SPRING?
   c) WHAT ABOUT USING CONDUCTIVE RUBBER SWITCHES LIKE PAM?
   d) NARROW ACTIVATOR BAR TO MAKE IT SPRINGY (TRIGGER)
   e) IS THERE AN ACTUAL STOP PIECE FOR ACTIVATOR BAR (TRIG)

2) NEED IMPROVEMENT OF JOYSTICK RESPONSE DIAGONALLY:
   a) in comparison testing, RC STELLA joystick responds better!
   b) check spacing of dome switches from edge of center hole

3) TEXTURING TO ALLOW BETTER GRIP ON CONTROLLERS

CIN

WRITER	DATE	WITNESS	DATE

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ENGINEERING LOG SHEET

GAME OR PROJECT: TRAKBALL DEVELOPMENT

→ FRANK H. HAS IDEA SUBMITTED FOR FIBER-OPTIC READ TRAKBALL
→ DOES DAVE ESTES KNOW? ANY CONSIDERATION?
→ WHAT ABOUT PAM-TO-COMPUTER ADAPTER FOR CONTROLLER PLUG?

12 WKS FOR SOFT TOOL
20 WKS FOR HARD TOOL } AFTER ALL INPUTS ARE RECEIVED

$47 COST = $100 RETAIL
PARTS
LABOR
PKGING.

MAR. 3 - SOFTWARE HAS TRAKBALL OPTION IN SOFTWARE
MAR. 7 - WORKING MODEL IN PLASTIC FOR SOFTWARE
MAR. 22 - SOFTWARE PROVIDES TRAKBALL SOFTWARE FOR MARKETING FOCUS GROUP MIS. COMM., SUP. BRKOUT, GALAXIAN, SP. INVADERS, CENTIPEDE FOOTBALL, BASEBALL(?) SOCCER

APR. 15 - INPUTS COMPILED FOR FINAL DECISIONS

MAY. 1 - FINAL PRODUCT SPEC'S RELEASED TO DEFINE PRODUCT

MID-SEPT: SOFT TOOLING
OCT: ATARI CUSTOMER WEEK
MID-NOV.: PRODUCTION TOOLING

GARY BLONDEFIELD
1399
MOFFETT
PKWAY

PAM CENTIPEDE

→ MUSHROOMS LOOK VERY GOOD, HAVE DIMENSIONAL (SHADED) EFFECT
→ FIELD TOO WIDE TO SIMULATE COIN-OP LAYOUT IN CHARACTER MAPPING
→ OPTIONAL PLAY TO SHOOT SIDEWAYS FROM RT. OR LT. EDGE OF FIELD
→ IMAGE DETAIL ON SPIDER & FLEA VERY GOOD: WILL EYES BE ADDED?

WRITER	PK	DATE	1/12	WITNESS		DATE	

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ENGINEERING LOG SHEET

GAME OR PROJECT: CINDY DYNAMIC TEST

VIBRATION & SHOCK TESTING FOR RESONANCE:

BRAD HOWLAND EXT 5852
ROD JENSEN 6957
MAIN UNIT #3
CONTROLLERS #1 & 6 DUE BACK WED, JAN 20

Consumer Electronics Division

Rodney Jensen
Industrial Designer

Atari Incorporated
1399 Moffett Park Drive
Sunnyvale California 94086
408 745 6957

A Warner Communications Company

Consumer Electronics Division

Brad Howland
Associate Industrial Designer

Atari Incorporated
1399 Moffett Park Drive
Sunnyvale California 94086
408 745 5852

A Warner Communications Company

WRITER	DATE	WITNESS	DATE

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT: CINDY REV 3 1ST ARTICLE

① ADD FILLETS TO ALL PAD-TRACES FOR XU1-XU7, SAME AS WAS DONE FOR THE CARTRIDGE SOCKET PADS

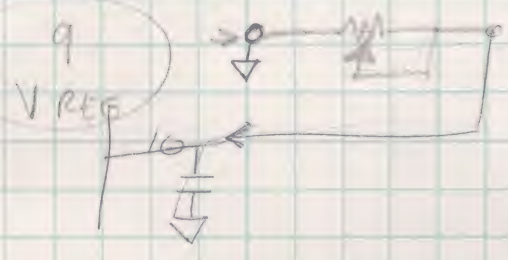
② CHANGE FERRITE BEAD DESIGNATIONS AS FOLLOWS: (ON SILKSCREEN)

FB1 TO L4 FB4 TO L7
FB2 TO L5 FB5 TO L8
FB3 TO L6

③ SHOW REF. DESIGNATIONS ON SILKSCREEN OUTSIDE OF COMPONENT OUTLINE WHEREVER POSSIBLE (FACILITATES VISUAL INSPECTION WHEN BOARD IS LOADED)

④ MAKE GND. PLANE SOLID AROUND THE 2 MOUNTING PADS FOR THE HEATSINK (NOT WAFFLED)

⑤



CINDY

WRITER	DK	DATE	1/21	WITNESS		DATE	

GAME OR PROJECT Trakball Specs

TALK TO G. LICHAC

MECHANICAL PERFORMANCE

ELECTRICAL PERFORMANCE

WRITER	DATE	WITNESS	DATE

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ENGINEERING LOG SHEET

GAME OR PROJECT

CENTIPEDE TRAKBALL : COST ESTIMATES FOR PARTS

CONSIDERATIONS:

ACCESS TO OIL BEARINGS

	STD	ACT
035931-01 ROLLER SHAFT.	2.12	1.50
036193-01 IDLER SHAFT	1.70	
035936-01 TRK-BALL	1.55	
035937-01 BEARING	.77	
035938-01 ENCODER	.35	.38
035191-01 192-01 FRAMES UP & LWR	.55 EA	

WRITER	DATE	WITNESS	DATE

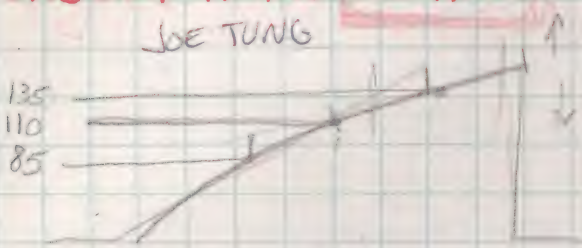
ATARI® **ENGINEERING LOG SHEET** 67

GAME OR PROJECT: PAM TRAKBALL : PROTOTYPE CALIBRATION

TB #1

ONE-SHOT TIMING = 2.5 MSec

JOE TUNG



STATIC : X = 110 Y = 119

	ΔX RT	ΔX LT	ΔY DN	ΔY UP
f = 60Hz	+4	-5	+5	-6
90	+6	-8	+7	-8
150	+11	-12	+12	-13
200	+15	-16	+16	-17
300	+24	-22	+28	-25
400	+34	-27	+39	-30

TB #2

ONE-SHOT = 2.0 msec

AL MOSS
(SUPER BREAKOUT)

STATIC : X = 109 Y = 117

	ΔX RT	ΔX LT	ΔY DN	ΔY UP
f = 60Hz	+4	-5	+5	-5
90	+7	-7	+7	-8
150	+11	-12	+12	-13
200	+15	-16	+16	-16
300	+25	-22	+25	-27
400	+35	-27	+37	-29

TB #3

BOB KOWOLIK

STATIC : X = 110 Y = 120

	ΔX RT	ΔX LT	ΔY DN	ΔY UP
f = 60Hz	+4	-5	+4	-5
90	+6	-7	+7	-8
150	+11	-12	+12	-13
200	+14	-16	+16	-16
300	+23	-22	+25	-23
400	+32	-27	+36	-29

TB #4

ROB ZDYBEL

STATIC : X = 108 Y = 118

	ΔX RT	ΔX LT	ΔY DN	ΔY UP
f = 60Hz	+5	-5	+4	-5
90	+6	-7	+7	-7
150	+11	-12	+11	-12
200	+15	-15	+15	-16
300	+24	-21	+24	-23
400	+34	-26	+36	-29

WRITER	DATE	WITNESS	DATE
DK	2/23		

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT
PAM TRAKBALL : PROTOTYPE CALIBRATION

TB#5
JIM HUETHER
ONE-SHOT TIMING =
2.0 msec

STATIC: X = 109 Y = 117

f = 60Hz	ΔXRT	ΔXLT	ΔYDN	ΔYUP
	+4	-4	+4	-5
90	+5	-5	+5	-5
150	+8	-10	+8	-10
250	+14	-15	+14	-16
350	+21	-20	+22	-20
450	+28	-24	+29	-26
500	+31	-26	+34	-28

TB#6

2.0 msec.

STATIC: X = 111 Y = 121

f = 60Hz	ΔXRT	ΔXLT	ΔYDN	ΔYUP
	+3	-4	+4	-5
90	+5	-6	+6	-6
150	+8	-10	+10	-11
250	+15	-16	+17	-17
350	+22	-21	+26	-23
450	+30	-26	+36	-28
500	+35	-28	+40	-30

TB#7

STATIC: X = Y =

TB#8

STATIC: X = Y =

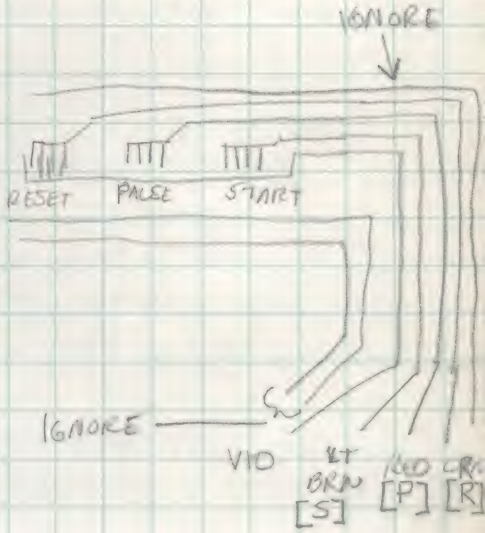
WRITER	DATE	WITNESS	DATE

GAME OR PROJECT: TRAKBALL CONSOLE MODEL

FLEX CIRCUIT CONNECTOR PINOUTS:

1 ... 11

PIN#		15 WIRE TRAKBALL CABLE	PAM CONN., PLANAR RIBBON COLOR	PAM CONN. PIN#
1	TRIG COMMON (GND)	ORN	BLK ✓	(15)
2	TRIG Ø (9 PIN VCS KEYBD.)	YEL	RED/BLK ← GRN/WHT	13
3	ROW 3 (4) YEL RT	GRN	YEL ✓	8
4	ROW 2 (3) ORN LT	BLU	ORN ✓	5
5	ROW 1 (2) RED DN	VIO	RED ✓	6
6	COL 2 (6) BLU	GRY	BLU ✓	1
7	COL 1 (9) WHT	WHT	WHT ✓	2
8	COL Ø (5) GRN	WHT/BLK	GRN ✓	3
9	ROW Ø (1) BRN UP	WHT/RED	(LT.) BRN ✓ GRN/WHT	7
10	COL 3 (~~GREY~~ VIO)	WHT/ORN	VIO ✓	4
11	SOFT FIRE GREY	WHT/YEL	GRY ✓	14
	TRAKBALL CLR. /CAV +5	BLK	(DK) BRN ✓	(9) <
	5V+ (~~PA7~~ COIN)	WHT/BRN	PINK RD/WHT	12 <
	X OUT (PAØØ)	BRN	GRN/BLK YEL/WHT	(10)
	Y OUT (PAØ1)	RED	WHT/BLK ✓	(11)



WHT + GRN = ?
WHT + BLU = SKIP 8

WRITER	DATE	WITNESS	DATE
DL	3/3		

TAS, LIQ
WICO T.B.
VILLA
C.F. W HOUSE

70

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT
MOTOROLA MC68000 16-BIT MICROPROCESSOR

CLOCK FREQ. NOW UP TO 12MHz CLOCK RATE - IMPROVEMENT IN PERFORMANCE OF MATHEMATICAL APPLICATIONS, INCLUDES REDUCTION OF INSTRUCTION CYCLE TIMES. COMPLETE TTL COMPATABILITY W/ GOOD CURRENT OUTPUT FOR LOAD DRIVING.

MC68008 - 60% PERFORMANCE (REDUCED BUS 68000)

ADVANCED CRT CONTROLLER:
(1) TERMINAL-TYPE GRAPHICS w/ OBJ. CODE, TREATS OBJECTS AS CHARACTERS
(2) RASTER GRAPHICS PROCESSOR.

NEED FAST SPEED ITEMS FOR BETTER GRAPHICS, BUT ALSO AFFECTS RADIATION LEVELS OF HARDWARE.

WRITER DK	DATE 3/4	WITNESS	DATE

GAME OR PROJECT

Breakball: Velocity Count Generation

TESTING

VARIABLES:

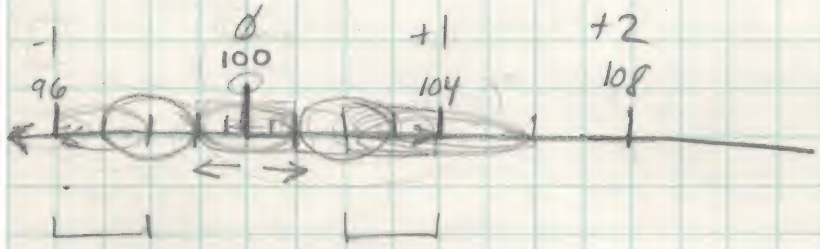
f_{IN} : INPUT CLOCK FREQUENCY > INVERSE PROPORTIONAL ($f_{in} \times T_{OUT} = 1$)

t_{OUT} : ONE-SHOT PULSE WIDTH

I_{PAD} : CURRENT ADDED OR SUBTRACTED TO POT LINES THRU R13-R16 (ADJUSTED BY R9-R12, LOWER R = MORE PULSED CURRENT IN WINDOW)

PADDLE # DIVISOR: PRODUCES VELOCITY COUNT BY DIVIDING PADDLE NO. BY 1, 2, 4, 8, 16, ETC.

INHERENT IDIOCY: ACTUAL STATIC PADDLE # POSITION CAN FAVOR ONE SIDE OF NO. SHOWN, WHICH ALLOWS FOR SLOP ON ONE SIDE OF PADDLE # LINE. VELOCITY COUNT GOES FROM 0 TO 1 WITH LESS BALL SPEED IN ONE DIRECTION THAN THE OTHER. IN PRACTICAL APPLICATION, INSTANTANEOUS RESPONSE IS MORE IMPORTANT FOR DOWN THAN UP IN Y AXIS MOTION (EASIER TO PHYSICALLY ROLL BALL UPWARD THAN DOWN)



VIDEO ANIMATION BOOK DUE OUT IN THE FALL

DAVID FOX

POT ÷ 4

$\frac{POT-2}{4}$ or $\frac{POT+2}{4}$

WRITER	DK	DATE 3/10	WITNESS	DATE

ATARI® **ENGINEERING LOG SHEET**

GAME OR PROJECT: PILOT RUN UNIT FAILING TO SET UP CINDY: SCREEN WHEN WARM

SUSPECT: 6507 MPU'S ARE RUNNING TOO FAST WHEN TRYING TO POWER UP & RESET. HAPPENS AFTER 5 MIN. OR SO OF WARMUP, THEN PWR. DN - PWR. UP. SCREEN IS OUT OF SYNC AND WILL NOT STRAIGHTEN UP.

→SPRAY FREEZE IN SHORT BURST ON 6507 STOPS PROBLEM AFTER PWR DN - PWR UP RESET.

TEST SETUP: CHECK A SUCCESSION OF 6507's WITH DIFFERENT DATE CODES, TO SEE IF OLDER ONES FAIL ALSO. CHECK AFTER 5 & 10 MINUTE WARMUP PERIODS, WITH SHIELD ON PCB. IF ANY FAIL, SEE IF SPRAY FREEZE ALSO STOPS THEM FROM FAILURE. NEW GAME CARTS USED: PACMAN, WARLORDS

CHIP #	DATE CODE	MFR.	COMMENTS
Ø (UNIT'S ORIGINAL)	8205		FAILS AFTER 5-10 MIN WARMUP BUT NOT ABSOLUTELY CONSISTENT
1	8104		WILL NOT FAIL
2	4380		WILL NOT FAIL
3	8009		FAILS EVERY TIME, EVEN FROM A COLD STARTUP
4	8005		
5	7818		

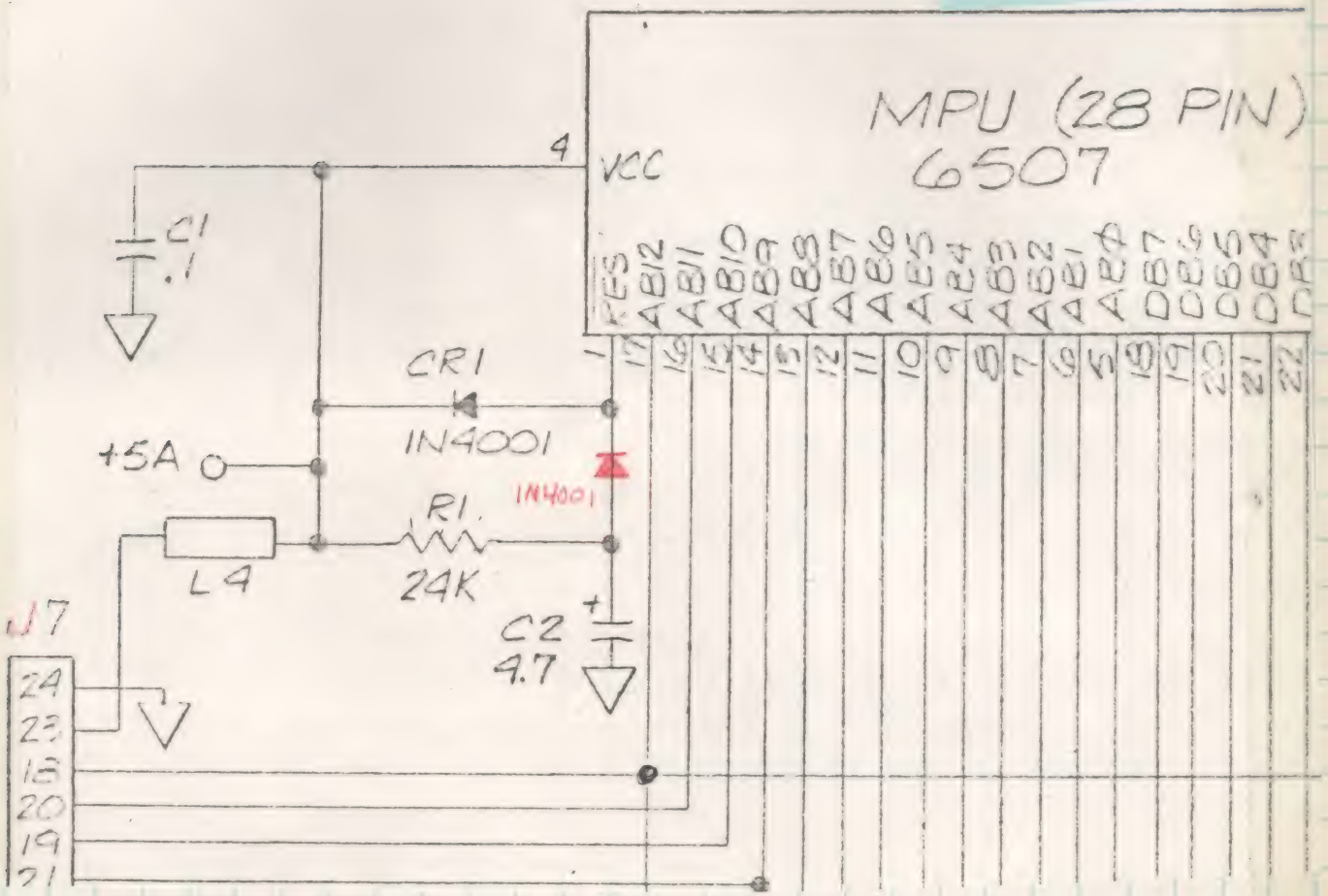
COMMENTS: MPU PAIRED WITH PIA FROM SAME UNIT; FAILS IN EITHER REV 3 OR REV 1A CINDY BOARD

CINDY

WRITER	DATE	WITNESS	DATE
DK	3/26		

GAME OR PROJECT
CINDY RESET PROBLEM

CINDY



NOTES: SUPPOSED SPIKE ON PWR. UP COULD CAUSE HICCUP IN 6507 RESET. ADDITION OF DIODE CLAMPS DOWN ON 5V RESET LINE AND PREVENTS FALSE TRIGGERING

SYNERTEK 6507 RESET THRESHOLDS

MOS TYPE:		SYNERTEK	
1	1.24V	1	1.25 V
2	1.14V	2	1.26 V
3	1.48 V	3	1.24 V
4	1.46 V	4	1.24 V
5	1.39 V	5	1.19 V
6	1.24 V		

WRITER	DATE	WITNESS	DATE
DK	3/29		

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT: TRAKBALL: NEW ENCODER WHEELS

ORIGINAL CENTIPEDE TB WHEEL: 24 SLOTS, PITCH DIA. 1.324"

PITCH DIA = DIST. ACROSS WHEEL BETWEEN CENTERS OF 2 OPPOSING SLOTS

PITCH CIRCUM = 4.16 IN

CENTIPEDE SLOT DIA @ PITCH = .084"
ALSO USABLE: .071", .060"

LIMIT
4° = .046" 6° = .069" 7.5° = .087
5° = .058 7° = .081

NEW WHEELS MADE, DEGREES OF TOTAL CIRCLE

		SLOT DIA.	BLANK DIA.
1)	30 HOLES:	6°	6°
2)	30 " :	5°	7°
3)	30 " :	7.5°	4.5°
4)	36 " :	5°	5°
5)	36 " :	6°	4°
6)	40 " :	5°	4°
7)	50 HOLES:	3.6°	3.6°

CAN'T REDUCE SLOT WIDTH BELOW .040 W/ OUT APERTURE:
CURRENT DEVICE (ORO220) HAS .035 LENS WINDOW W/ NO APERTURE.

8)	75 HOLES:	2.4°	2.4°
9)	100 HOLES:	1.8°	1.8°

.420
.035
.084

THURS. MTG. (ALL DAY?)

FINALIZATION
NEW MEMO, MORE INFO
→ DROP 3rd FIRE BUTTON
→ STRESS FULL CAPABILITY: LAP PLAY, K-BOARD
→

WRITER	DATE	WITNESS	DATE
DK	4/7		

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ENGINEERING LOG SHEET

75

GAME OR PROJECT: RCA OPTEK

CMOS INTERFACE, HAS LOW I_C OUTPUT REQUIREMENTS FOR PHOTO X ISTOR OUTPUT (DON'T NEED PHOTO DARLINGTON)

WITH, W/OUT APERTURE, STRAIGHT OR CURVED PATH FOR CHANNEL

"BRAINSTORM MEETING" APRIL 16

→ MAJOR INADEQUACY OF PAM JOYSTICK STILL IGNORED, WON'T BE CHANGED
→ MORE CONNECTION W/ MARKETING STILL NEEDED
→ 3-D HELMET SIMULATOR BY GEORGE & RON
→

OPTEK

OPTEK, A DIVISION OF CROWN SEMICONDUCTOR, INC.
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McKINNEY, TEXAS 75069
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TWX 910-338-7352

WRITER	DK	DATE 4/15	WITNESS	DATE

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT: NEW PRODUCT "BRAINSTORM" — PRODUCT DEFINITION

TOPIX

2200 STELLA (CHEAPEST, NO FRILLS)
2900 STELLA (REPACKAGED 2600A)
TRAKBALL
PAM SPEECH

2200: (EL CHEAPO SUPREMO) APPROX. $100 RETAIL, $40-50 COST TO US
CONTROLLERS ON CONSOLE, NO DIFF SWITCHES
ONLY 3 SWITCHES (PWR ON-OFF, SELECT, RESET)
2-CHIP 'TRONIX
RUBBER-SWITCH CIRCULAR JOYSTICK-ACTION CONTROL, W/ FINGERTIP ACTIVATION
CHECK OUT NEW TYPE CONTROLLERS QUICK

PRO POINTS
- INDENTED POSITIONS ON CONTROLLER SURFACE
- CARTRIDGE STORAGE (TITLES VISIBLE BETTER)
- 1 DEDICATED ROM W/ UNIT (INSIDE GAME)
- CARRYING HANDLE FOR PORTABILITY

CON POINTS
- NO PADDLE GAMES PLAYABLE
- CARTRIDGE COULD CRAMP HAND POSITIONS
- CART. STORAGE REDUCES NEED FOR EXT. ACCESSORIES STORAGE
- RUBBER SWITCH TECHNOLOGY NOT COMPLETE (WHAT IS GAME PLAY LIKE W/ NEW CONTROLLER?)

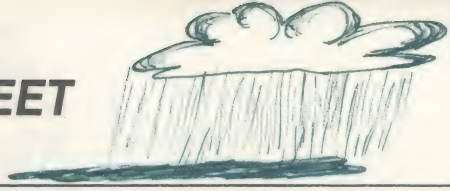
2900: (MINDY) ENHANCED STYLING & CAPABILITY COMPARED TO 2600 VCS SOFTWARE, SLIGHT PREMIUM OVER 2600, IN EXPECTATION OF DROPOFF OF ITS LIFE IN MARKETPLACE (BY JAN '84)
REDUCED CHIPSET & PCB EXPENSE
DC SWITCHBOX (MANUAL), 4 CONTROLLER PORTS
NEW HUMAN-ENGINEERED CONTROLLER, INCL. SEL-RESET BUTTONS, WITH LEFT-RIGHT FIRE BUTTON CAPABILITY
$150 WHOLESALE, $199 RETAIL

PRO POINTS
- PROVISION FOR FULL KEYBOARD
- LED INDICATORS
- COMBO CONTROLLERS + SPECIAL CONTROLLERS
- ADDITIONAL LINES TO CART. CONNECTOR

CON POINTS
- CONTROLLER PORT ACCESS
- NEEDS "SHOT IN ARM" FOR FUTURE SOFTWARE

WRITER DK	DATE 4/22	WITNESS	DATE

ATARI® **ENGINEERING LOG SHEET**



77 RAINING IN MY HEART...

GAME OR PROJECT
NEW PRODUCT "BRAINSTORM"

PAM

- ☐ FUTURE CAPABILITIES MUST BE SEMI-DEFINED SOON TO
- ☐ ALLOW FOR PRELIMINARY DESIGN RESEARCH

→ KEYBOARD
→ DISC DRIVE
→ SPEECH
→ AUDIO-STEREO ENHANCEMENT
→ MODEM LINKUP
→ VIDEO DISC INTERFACE
→ WEATHER
→ BIO-MEDICAL
→ SEXUAL FULFILLMENT

TRAK BALL

MARKETING
NEW POSITION (FAVORABLE) FOR KEYBOARD INCLUSION IN DESIGN. COST REDUCTION NOW ALLOWS FOR IT. RESULTS OF QUIK-SHOT MKTG. FOCUS GROUP ON TRAKBALL WERE NOT SATISFYING TO PEOPLE AT BRAINSTORM - QUESTIONS RAISED ABOUT FORMAT FOR FUTURE FOCUS GROUPS: OUTLINE IN ADVANCE TO DESIGN GROUPS TO ALLOW FOR FEEDBACK & QUESTIONS TO BE ANSWERED, TO HELP DEVELOP OUTLINE FOR FOCUS GROUP FORMAT.

MOONE SEZ: "IT'S WORTH $89-$99, COMPARED TO 400-800 'ENTERTAINER PACKAGE' - MAKE IT GOOD!"

NEW WICO TB PARTS WILL BE AVAILABLE FOR EVALUATION SOON

ALL DOUBLES FOR C.E.S.! 6 UNITS: 2 ON FLOOR, 4 BACKUPS

TOMORROW (FRI, 4/22): SEE DENNIS SITCLER ABOUT WICO TB PARTS.
RELEVANT POINTS 1) ROLLER DIA. & MATERIAL
2) POSSIBLY DIFF. ENCODER WHEEL
3) WHAT TYPE OF BALL?

ES PROMO, TRAKBALL MANUAL?

SPEECH: NO ROBOT VOICES TARGET: $50 MODULE

1) CAPABILITY INSIDE GAME CARTRIDGE
2) " " 'MINI-CART' WHICH PLUGS INTO REAR MODULE

USE IT AS A CUE IN GAMEPLAY, RATHER THAN AS A REWARD OR PATENT COVERAGE FOR ALL SITUATIONS.

MEMORY CONSERVATION VERY IMPORTANT: 10 sec's TAKES UP 2K BYTES

WILL WE BUILD UP OUR OWN SPEECH LAB? YOU BETCHUM, R.R.!

WRITER	DK	DATE 9/22	WITNESS	DATE

ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT 6507 RESET PROBLEM

SYNERTEK CHIPS UNDER FIRE!

A) DIODE IN LINE W/ RESET PIN, FIXES BUT REQUIRES PCB REVISION (NO!)
B) REDUCE R1 FROM 24K TO 12K, C2 FROM 4.7μf TO 2.2μf
TO CUT DOWN RESET TIME CONSTANT.
RESULT: STILL HAS PROBLEM
RC VALUES VARIED FURTHER: R = 12K OR 24K, C = .47μf, 1μf, 2.2, 4.7, 10μf
STILL NO TOTAL EXCLUSION OF RESET PROBLEM

2600A BOARD EXHIBITS SAME, BUT WORSE!

WRITER	DK	DATE	4/22	WITNESS		DATE	

ATARI®

ENGINEERING LOG SHEET

GAME OR PROJECT: CONSOLE TB CIRCUIT IMPROVEMENTS

CONSTANT-CURRENT DEVICE TO CHARGE OUTPUT CAPACITOR:
1) WILL LINEARIZE OUTPUT RANGES
2) BETTER PROPORTIONALITY BETWEEN DIRECTIONS
3) CHEAP AS A CUSTOM CHIP OR SINGLE-COMPONENT

PRESENT OUTPUT CIRCUIT IS NOT VERY LINEAR BECAUSE IT IS A

Q: DOES PHOTOXISTOR HAVE SUFF. START ON-TIME

DON'T FORGET TO: CMOS PCB! [OR RECT. CONCAVE]

→ ENLARGE & SMOOTH FIRE BUTTONS [ROUND]

→ USE SNAP-ACTION SWITCHES ON PCBs FOR KEYPADS SNAP INTO PLACE
NO FLEX CIRCUITS OR CONDUCTIVE RUBBER!
(WILL REDUCE DIFFICULTY OF ASSEMBLY!)

→ ALLOW UNIT TO BE SET UP OPEN W/ KEYBOARD STILL CONNECTED (OR USE EXTENSION JUMPERS)

PATENT FILE #6996P-239

(202) 347-0585
JAY CANTOR-WASH ATTORNEY FOR PATENT FILINGS
MIKE SHERRARD (408) 745-5042
BISMARCK HOTEL FRONT DESK — 236-0123
BOB BENNETT: (415) 543-9600

MADISON & LASALLE N.W. CORNER OF LOBBY 554-9000
ASK FOR BELL (312) 236-0123
(BISMARCK) CAPTAIN

→ ISOLATE OR PROTECT START-PAUSE-RESET SWITCH LINKS FROM ACCIDENTAL RESET [FRAME]

WRITER	DK	DATE 5/3	WITNESS	DATE

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ENGINEERING LOG SHEET

GAME OR PROJECT

TB CIRCUIT IMPROVEMENTS

→ FRONT END OPTOCOUPLE RIG [JIM GERARD] ← PRIORITY
✓→ CHECK ON SCHEMATIC
→ BACKGROUND FOR CMOS PCB
✓→ MAKE NEW ENCODER WHEEL SAMPLES
→ TRAKBALL PACMAN STATUS, OTHER GAMES COMING UP (SPORTS)
→ WHAT ABOUT CENTIPEDE?
→ CONTACT JOHN HAYASHI Re: GOOD LOGO!
→ DEMON ATTACK VCS TRAKBALL?
→ NEW-STYLE SNAP ACTION SWITCHES & CONCAVE SWITCH CAPS (FIRE BUTTONS)

PAM TRAKBALL DOCUMENT NO's.

LOWER PCB:	SUB-ASSY DWG	1 CA020141
	" PTS. LIST	1 CA020141
	SCHEMATIC	1 CA020140
UPPER PCB:	ASSEMBLY DWG	1 CA020140
	PARTS LIST	CA020140
UPPER PCB:	SUB-ASSY. DWG.	
	" PTS. LIST	1 CA020287
	SCHEMATIC	1 ~~CA020286~~
	ASSEMBLY DWG.	
	PARTS LIST	

6 SHEETS TOTAL

WRITER	DATE	WITNESS	DATE

GAME OR PROJECT: PAM TRAKBALL — POINTS OF DEVELOPMENT AND PROMOTION

(1) IMPROVEMENT OF FRONT END ENCODER RESOLUTION:
CURRENT ENCODER USES 24 SHUTTERS:
→ INCREASE TO 50-75-100 SHUTTERS, WHICH WILL REDUCE REQUIRED PULSE WIDTH OUT OF ONE-SHOT USED TO DRIVE PULSE CURRENT INTEGRATOR. HOPEFULLY, THIS CAN HAVE A NET EFFECT IN SEVERAL WAYS:
A) VALUE OF GIANT RIPPLE-SMOOTHING CAP CAN BE REDUCED, STILL ALLOWING LESS RIPPLE TO APPEAR ON RAMP WAVEFORM AT LOW BALLSPEEDS, WHICH ALLOWS FOR SMOOTHER TRANSITIONS FROM STOP-TO STARTUP OF CONTROLLED IMAGE (OR WHEN CHANGING VELOCITIES)
B) DELAY IN RESPONSE MAY BE REDUCED WITH SMALLER RIPPLE-SMOOTHING CAP [HYSTERESIS PROBLEM]
C) GRADATIONS OF VELOCITY SIGNALS WILL BE FINER, ALLOWING FOR BETTER SOFTWARE PROGRAMMING AND GAME PERFORMANCE IN THE FUTURE.
→ REPOSITIONING OF OPTICAL EMITTER-DETECTOR PAIRS IS NECESSARY TO SUCCESSFULLY MAKE USE OF NARROWER SHUTTER WIDTHS OCCURRING W/ GREATER NO. OF SHUTTERS

VERTICAL POSITION DOES NOT ALLOW FOR USE OF NARROWER SHUTTERS ON ENCODER WHEEL OR DETECTOR APERTURES, CURVED CHANNEL IN DEVICE WILL NOT PERMIT CLOSE PROXIMITY OF WHEEL TO DETECTOR FOR GOOD ON-OFF SENSING RESOLUTION.

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GAME OR PROJECT: JAM TRAKBALL — POINTS OF DEVELOPMENT AND PROMOTION

(2) QUALITY LONG-THROW SNAP ACTION SWITCHES MUST BE USED FOR THE FIRE BUTTONS (QUANTITY FOUR). THE CHEAPIE SNAP-ACTION SWITCHES USED FOR C.E.S. PROTOTYPE TRAKBALLS DID NOT HOLD UP WELL UNDER THE CONTINUAL BARRAGE OF FRANTIC, POUNDING, SLAPPING BUTTON TREATMENT APPLIED BY THE MAJORITY OF THOSE WHO PLAYED WITH THEM. HOWEVER, THESE LO-COST SWITCHES WILL BE TOTALLY SUITABLE FOR USE ON THE KEYPADS OR START-PAUSE-RESET SWITCH BANKS. THEY ONLY NEED TO HAVE CORRECT-SIZE CAPS MOLDED TO FIT THE EXISTING KEYPAD STYLING CONFIGURATION.

SHAPE OF FIRE BUTTONS STILL UNDER DETERMINATION - DEFINITELY SHOULD BE LARGER THAN ON PROTOTYPES AND HAVE FINGERTIP DEPRESSIONS. [ROUND OR RECTANGULAR]

(3) OUTPUT CIRCUIT HAS SOME DIRECTIONAL NON-LINEARITY AT HIGHER INPUT CLOCK SPEEDS (ABOVE 250 Hz IT BECOMES QUITE NOTICEABLE AND WILL CAUSE PROBLEMS). FOR EXAMPLE, THE CHANGE FROM REF. NO. TO THE X_{RT} VALUE @ 400 Hz IS APPROX. 35 (PADDLE COUNT), WHILE ΔX_{LT} IS ONLY 27 (THESE NO's. TAKEN FROM PROTOTYPE TESTING). DIFFERENCES IN VELOCITY GENERATED FROM THESE TWO OBVIOUSLY DIFFERENT RATES OF CHANGE WILL CAUSE POOR REPEATABILITY IN BACK-AND-FORTH MOVEMENT ON THE X AXIS AT HIGHER SPEEDS - SAME WILL BE TRUE FOR THE Y AXIS. IMPROVEMENT OF THIS SITUATION IS DEFINITELY IN ORDER!

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GAME OR PROJECT: PAM TRAKBALL — POINTS OF DEVELOPMENT AND PROMOTION

(4) INTERACTION WITH SOFTWARE GROUP DURING DEVELOPMENT IS ESSENTIAL.

→ RESPONSE OF THE TRAKBALL DURING GAME PLAY IS NECESSARY TO BE AWARE OF DISCREPANCIES IN BOTH HARDWARE AND SOFTWARE: CURRENT GAME BEING MONITORED IS FRANK HAUSMANN'S CENTIPEDE

→ DEVELOPMENT OF NEW OR MORE VERSATILE APPLICATIONS FOR TRAKBALL STILL NEED TO CONTINUE TO ALLOW FOR BEST USE OF TRAKBALL. CASE IN POINT: JOKE ATTEMPT AT TRAKBALL FOR PAC MAN WITHOUT USING CORRECT ROUTINE TO READ CONTROLLER.

(5) USE OF CONDUCTIVE RUBBER SWITCHES FOR KEYPADS IS NOT ACCEPTABLE FOR THE TRAKBALL. IN KEEPING WITH THE CONCEPT OF SUPERIOR PERFORMANCE WHICH WILL FACILITATE THE HIGHEST DEGREE OF GAME PLAY POSSIBLE, SWITCHES MUST BE USED WHICH WILL PROVIDE SENSORY, TACTILE FEEDBACK. THE PLAYER SHOULD KNOW THAT ANY SWITCH-RELATED FUNCTION HAS BEEN ACTUATED BY AS MANY SENSORY SIGNS AS CAN BE PROVIDED: A) VISUAL DISPLAY CHANGE ON VIDEO SCREEN
B) AUDIO CUE FROM GAME PROGRAM
C) DEFINITE TACTILE SNAP FROM SWITCH
D) AUDIBLE CLICK FROM SWITCH

FACTORS C) & D) BOTH CONTRIBUTE TO MINIMIZING THE AMOUNT OF TIME NECESSARY TO ACTUATE THE SWITCH AND THEN MOVE ON TO THE NEXT ACTIVITY IN THE GAME. THIS WILL BECOME MORE CRITICAL AS FUTURE GAMES DEMAND QUICKER RESPONSES, AND SHORTER DECISION TIMES AND MORE COMPLEX CONTROL SEQUENCES.

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GAME OR PROJECT: TRAKBALL — ENCODER RESOLUTION IMPROVEMENT

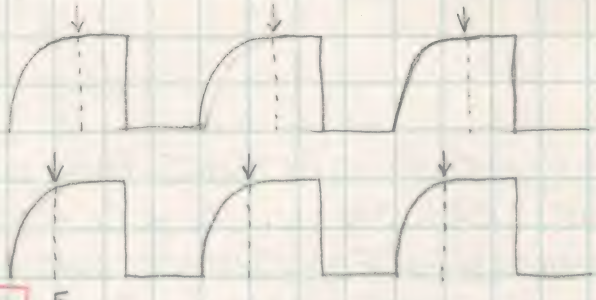
24 SHUTTER WHEEL:
7.5° PER SLOT OR SPACE

6.48 SPACES
75 | 486.
450
360
360
0

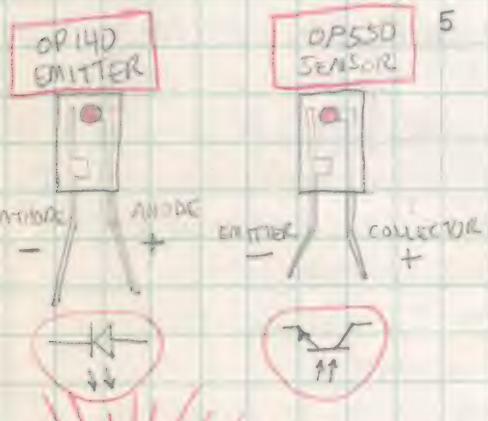
13.5 SLOTS
3.6° EACH
8.10
40.50
48.6° DETECTOR CENTER TO CENTER

DOUBLE INPUT RESOLUTION
DECREASE INPUT TO ~1.5MSEC

QUADRUPLE INPUT RESOLUTION
DECREASE INPUT TO ~1.0MSEC



OTHER CONSIDERATIONS:
1) TRY TO REDUCE OUTPUT CAPACITOR
2) ADJUST CURRENT WINDOW NETWORK
3) LINEARIZE DIR. OUTPUT (DIODES?)
4) BASIC POTRIM PROGRAM



ALTERNATIVE EMITTER (LO-COST OF COURSE!)

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GAME OR PROJECT

NEW PROJECTS SUGGESTIONS 7/14/82

- Muppette idea for children
- Expansion box for computers
- New generation for graphics chip, game-oriented processor
- More work with robots
- Table top games using lasers
- BSR radio frequency control systems to operate various items around home
- Fiber optics light pen
- DOME PROJECTION SYSTEM FOR TOTAL INVOLVEMENT GAMES
- Use of a mouse
- More work on touch pads
- Emotion sensitive controller
- Monitoring systems for aircraft
- Developing trigger type joysticks - engineered to fit the hand correctly!
- Solar powered toys
- Vector graphics
- Using microprocessor Stella for more than just video games i.e. home central control system applications, monitoring automobile functions
- Radio control system - using pot variation as FM and joysticks variations as AM
- Holographic displays
- Controller w/ LCD display

Areas Needing Development:

View Data
Teletex
Prestel
Components
Flat CRT's
Displays
Die Bonded Displays

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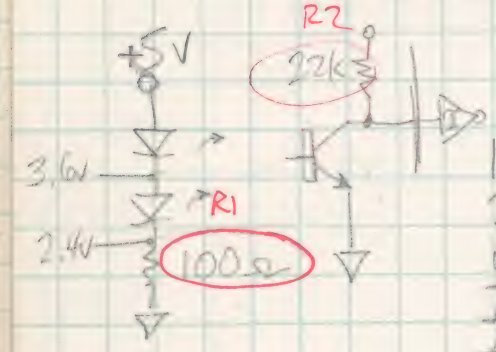
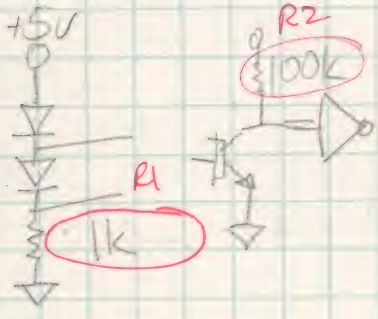
GAME OR PROJECT: TRAKBALL CURRENT REDUCTION

I_{CKT} = BREADBOARD W/OUT OPTOS



1.3V ACROSS EACH DIODE (V_D)
24 mA I_F
w/ 4V V_{CE} I_C = 600 μA
I_{TOTAL} = 56.3 , I_{CKT} = 10.6mA
t_R = 300 μsec



V ACROSS DIODE
I_F = 12 mA
I_C = 100 μA, ONLY PULLS DOWN 1V P-P ON OUTPUT
INSUFFICIENT

R_1	R_2	V_D	I_F	I_C	I_{TOTAL}	I
470	75k					

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GAME OR PROJECT: VCS TRAKBALL

INITIAL CONCEPT:

PERFORMS JOYSTICK EMULATION WITH VELOCITY CONTROL FROM A STANDSTILL UP TO FULL SPEED AFFORDED (SAME AS STANDARD JOYSTICK SPEED). ACCELERATION RATE NEEDS TO BE PRETTY QUICK TO ALLOW FOR QUICK STARTUPS, SINCE SOME VCS GAMES REQUIRE QUICK INSTANTANEOUS SPEED TO PLAY WELL (EXAMPLE: YAR'S REVENGE)

CIRCUIT CONFIGURATION

EMPLOYS EXISTING CIRCUIT DEVELOPED FOR ~~PAM~~ TRAKBALL UP TO INPUTS OF PULSE CURRENT INTEGRATORS. MEASURED PULSE CLOCKS OUT OF THE ONE-SHOTS (REF A3)

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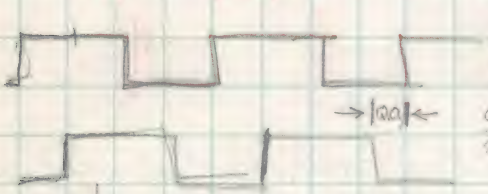
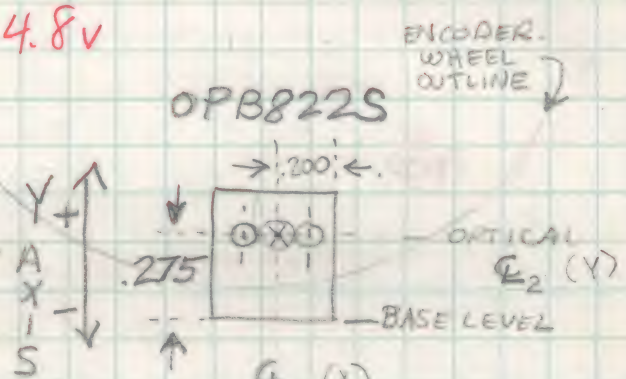
GAME OR PROJECT
OPTOCOUPLER POSITIONING TESTS

TEST CONDITIONS:
USING STRAIGHT-LINE OPTOCOUPLER 822S, ENCODER WHEEL 1.475 O.D., 1.342 PITCH DIA., 40% ON 60% OFF
V_{CC} = 5V
I_F = 24 mA
V_C = 4.7V P-P, DOWN TO .1V FROM 4.8V
R_C = 22k
I_S = 220 mA
PRF = ~~1KHz~~ 500Hz



$X = \text{¢}_1$, $Y = \text{¢}_2$
55-45 DUTY CYCLE
QUADRATURE OVERLAP ≈ 0



$\Delta\text{¢}_1$	$\Delta\text{¢}_2$	DUTY CYCLE	Q.O.	NOTES
Ø	Ø	55-45	80°	
±.100	Ø	"		ROCK SOLID
±.150	Ø	"		DROPOUTS AT END
Ø	+.010	"	60°	55° Q.O
Ø	−.010	"	50°	
Ø	+.020	"	70°	
Ø	−.020	"	40°	
Ø	+.030	"	80°	DROPOUTS BEGIN
Ø	−.030	"	30°	
Ø	+.040	"	90°	SERIOUS DROPOUTS
Ø	−.040	"	20°	WHEEL HITS CHANNEL BOTTOM

$\Delta\text{¢}_1$	$\Delta\text{¢}_2$	Q.O.	NOTES
±.050	+.010		OK
	−.010	REPEATS AS IN LEFT-SIDE DATA; NO WORSE THAN 30°	OK
	+.020		OK
	−.020		OK
	+.030		DROPOUTS BEGIN
	−.030		OK
	+.040		SEVERE DROPOUTS
	−.040		WHEEL HITS BOTTOM
±.100	+.010	Q.O.	OK
	−.040		OK
	+.040		OK
	−.020		OK
	+.030		DROPOUTS BEGIN
	−.030		OK
	+.040		SEVERE DROPOUTS
	−.040		WHEEL HITS

RESULTS SAME FOR + OR − X POSITION

RECOMMENDED SAFETY ZONE FOR 1.475" WHEEL IS ±.025 FROM OPTICAL CENTER (Y AXIS)
USE OF SMALLER WHEEL (1.4") WITH SMALLER SHUTTERS REDUCES SAFETY ZONE TO ABOUT ±.015"

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GAME OR PROJECT: JAM TRAKBALL PCB 1ST ARTICLE REV 0

1. TRACES NEED TO BE SWAPPED FOR OUTPUTS OF U2 LEADING IN TO A1 PINS 5 & 9
2. ADD FILLETS WHEREVER POSSIBLE

CALIBRATION CHECK

VOLTAGE @ C7 & C8 → VSTAT X=3.70V Y=3.70

STATIC: X=116 Y=125

X ONE-SHOT = 1.1 msec

Y ONE SHOT = 1.1 msec

	ΔXRT	ΔXLT	ΔYDN	ΔYUP
f=100Hz	+6 3.58	-8 3.88	+6 3.58	-8 3.88
200	+9 3.53	-11 3.94	+9 3.54	-11 3.94
300	+13 3.46	-15 4.06	+13 3.46	-15 4.04
400	+17 3.39	-19 4.15	+17 3.40	-18 4.12
500	+21 3.32	-22 4.26	+22 3.33	-22 4.23
600	+26 3.26	-25 4.35	+27 3.26	-25 4.32
700	+31 3.19	-28 4.45	+32 3.20	-29 4.41
800	+37 3.12	-30 4.55	+38 3.14	-31 4.50
900	+41 3.07	-32 4.62	+44 3.07	-34 4.61

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MC 14584 BCP
EQUIV. OF 4010GB

NATL, R.C.A.,

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ENGINEERING LOG SHEET

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GAME OR PROJECT: TRAKBALL TEST ENGINEERING

EX. 2344

BILL FITZMORRIS: NEEDS LAB UNIT, PAPERWORK (SCH., ETC.)
1183) TEST SPECIFICATIONS

STEVE ELGIN EXT ~~345~~ 773-9200 FIELD SERVICE NEEDS TTL LAB UNIT AND PAPERWORK FOR PAM TRAKBALL

NEED 6 BREADBOARDED 2000 TB'S FOR ADVANCE INFO PURPOSES
1) LIN NYBERG ~~EXT~~ PROD. ENG. EXT 4832 (W/JOHN NORMAN)
2) BOB RILEY EXT. 5008 1180 BLDG.

PRODUCTION TESTING:

→ BARE PCB TEST (INCOMING INSPECTION)
→ LOADED PCB ASSY TEST ON FIXTURE
→ BASE ASSY TEST W/ OR W/OUT BALL
→ INSTALL BALL, ASSEMBLE TOP & BOTTOM, DO KEYBOARD TEST
→ FINAL, COMPLETE ASSEMBLY TEST (FUNCTIONAL)

CX22 COST ACCOUNTING JOHN GONIA (CALL MIKE)

WRITER DL	DATE 10/15	WITNESS	DATE

GAME OR PROJECT "COMMAND CONTROL" HAH!
WICO TRACKBALL CHECKOUT

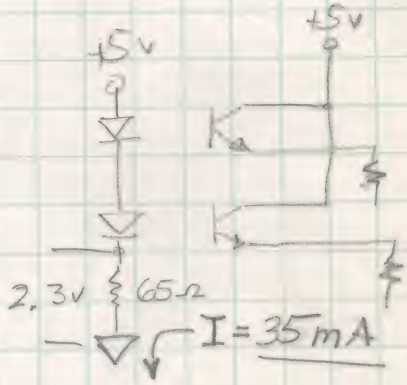
CURRENT DRAW:

TB1 : 156-159 mA
TB2 : 163-165
TB3 : 149-151
TB4 : 145-147

35mA PER COUPLER, 80-90 PER CHIP

ONE-SHOT TIMING:

X	Y
8 msec	8 msec
8	8
8	8
8	8



QUADRATURE CHARACTERISTICS

INPUT SIGNALS FROM COUPLERS: TB1

XCK1	4.4 v	X-QUAD ON INPUTS LOOKS OK
XCK2	2.5v	
YCK1	2.5 v	Y-QUAD ON INPUTS LOOKS MARGINAL
YCK2	4.4 v	

LOSES QUADRATURE & DROPS OUT

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GAME OR PROJECT: CX53 TRAKBALL TEST REQUIREMENTS

A CONFIRM SYMMETRY OF A1 OUTPUT CLOCKS: 50% DUTY CYCLE (TP1 & 2, TP3 & 4) IS IDEAL; 60-40 EITHER WAY IS LIMIT ON VARIATION

CAUSES OF NON-SYMMETRY:

1) POOR PERFORMANCE BY PHOTOXISTOR IN OPTOCOUPLER
2) INCORRECT COLLECTOR RESISTANCE ON PHOTOXISTOR
3) MARGINALITIES IN MECHANICAL POSITIONING OF ENCODER WHEEL TO OPTOCOUPLER ON PCB

B QUADRATURE: PHASE RELATIONSHIP OF THE TWO X CLOCKS AND TWO Y CLOCKS IS CRITICAL TO RELIABLE OPERATION. IDEAL QUADRATURE IS A 90° SPLIT BETWEEN THE LEADING & TRAILING EDGES - THIS IS BEST ACHIEVED WHEN THE TWO CLOCKS ARE 50% DUTY CYCLE. AS THE COMPARED EDGES OF THE CLOCKS APPROACH EACH OTHER, A2 OUTPUTS (DIRECTION SENSE) MAY BECOME LOGICALLY INTERMITTENT AND CAUSE CONFUSED ACTION ON THE TV SCREEN.

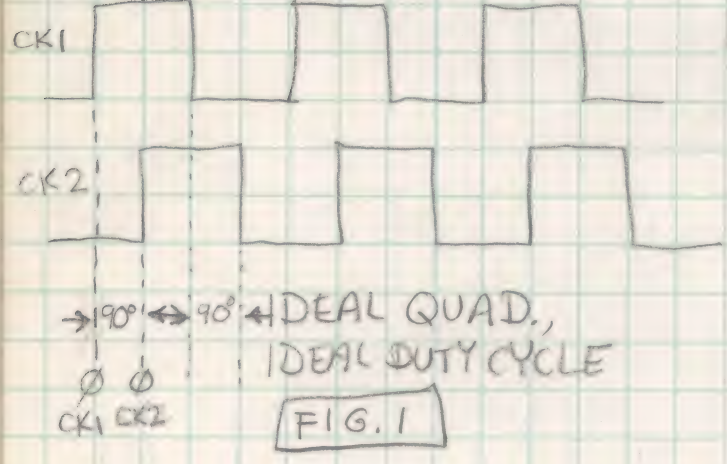

FIG. 1

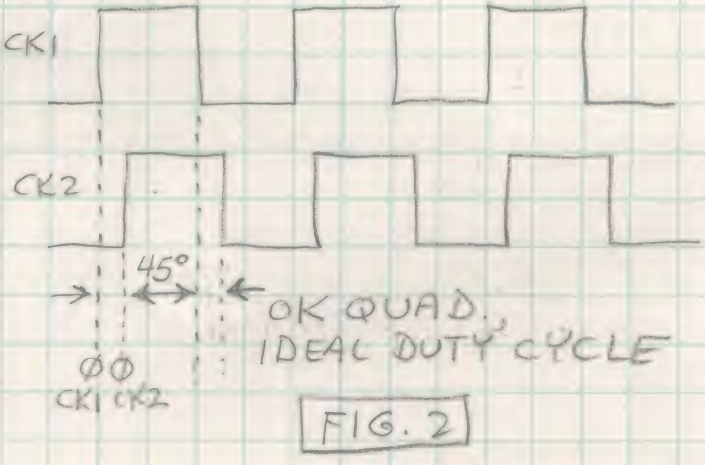

FIG. 2

FIG. 1 SHOWS THE BEST OF ALL CONDITIONS FOR MAXIMUM RELIABILITY, WITH THE LEAST LIKELIHOOD OF MARGINALITY. FIG. 2 SHOWS A SITUATION IN WHICH THE DUTY CYCLE OF THE TWO CLOCKS IS CORRECT BUT QUADRATURE IS OFFSET, WHICH OCCURS MOST OFTEN WHEN THE ENCODER WHEEL IS

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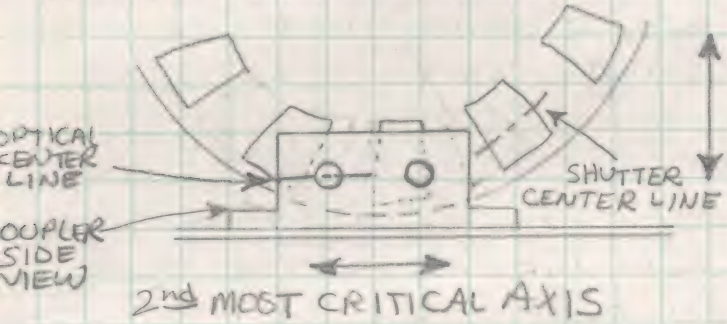
GAME OR PROJECT

CX53 TRAKBALL TEST REQUIREMENTS

NOT OPTIMIZED TO THE OPTICAL CENTERS OF THE COUPLER'S SENSORS. OF THE 3 AXES OF MOVEMENT IN RELATING THE WHEEL TO THE COUPLER, THE MOST CRITICAL ONE IS THAT IN WHICH THE WHEEL MOVES UP AND DOWN IN RELATION TO THE HORIZONTALLY-BASED COUPLER. SEE ILLUSTRATION BELOW.



THE 3rd AXIS (WHEEL NOT CENTERED INSIDE COUPLER'S .100" WIDE SLOT) IS THE LEAST CRITICAL.

FIG. 3

WHEN THE CLOCK'S DUTY CYCLE IS NOT EQUALLY OFF AND ON, QUADRATURE ALSO BECOMES MORE MARGINAL. IF THE PHASE SHIFTS FROM POOR MECHANICAL COUPLING AND UNEQUAL DUTY CYCLE, THERE IS A MAJOR TENDENCY TO FAIL QUADRATURE.

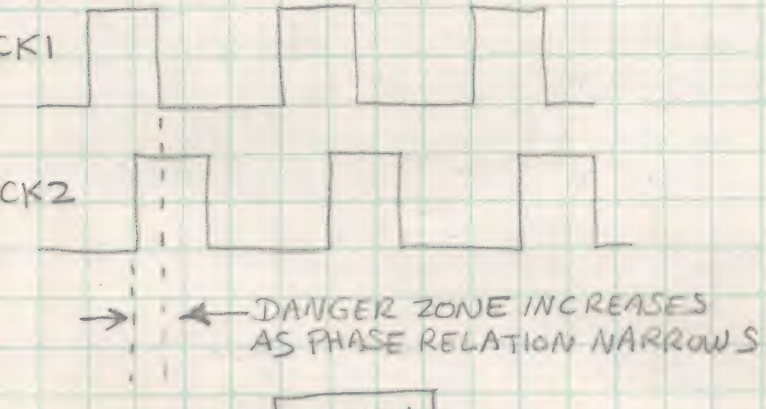


FIG. 4

IN ADDITION TO COMPARING THE TWO CLOCKS FOR EACH AXIS, LOOK FOR THE EFFECTS OF A MARGINAL PHASE RELATION TO APPEAR AS AN INCONSISTENT HIGH OR LOW ON THE OUTPUTS OF A2. THE MOST COMMON DROPOUT SITUATION OCCURS WHEN THE TRAKBALL IS SPUN ABRUPTLY FROM A STANDSTILL WITH A QUICK SLAP, AS IN AN EMERGENCY GETAWAY SITUATION, OR DIRECTION IS REVERSED QUICKLY IN A SINGLE-AXIS GAME.

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DK 11/4			

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GAME OR PROJECT
CX53 TRAKBALL TEST REQUIREMENTS

[C] ACCELERATION RATE: THE RATE AT WHICH THE SIGNAL REACHES ITS TOP SPEED INFORMATION LEVEL IS DETERMINED BY THE WIDTH OF THE OUTPUT PULSES PRODUCED BY THE ONE-SHOT A3. SPECIFIED WIDTH, SET BY THE R5-C5 AND R6-C6 NETWORKS, IS 1.0 msec ± 100 μsec. A NARROWER PULSE WIDTH WILL NOT ALLOW RAPID ENOUGH ACCELERATION, WHICH IS REQUIRED IN EMERGENCY SITUATIONS. AT TP9 & TP10

[D] ANALOG OUTPUTS: TP11 & TP12 SHOULD EXHIBIT THE 3.0V RAMP AS SHOWN BELOW. THE DECIMAL POT READINGS WHICH ARE PRODUCED BY POKEY IN THE 5200 CONSOLE SHOULD BE AT A MEDIAN VALUE (115 ± 10 DECIMAL, 73±10 IN HEX) AND RANGE TO ABOUT 40 COUNTS MAXIMUM ON EACH SIDE OF THIS STATIC VALUE AS THE BALL IS SPUN TO TOP SPEED OF 1kHz CLOCK RATE. THIS CHANGE FROM THE STATIC VALUE IS REFERRED TO AS Δ POT. FULL-RANGE Δ POT READINGS FOR "LEFT" AND "UP" WILL BE SOMEWHAT LOWER THAN THOSE FOR "RIGHT" AND "DOWN." THESE DIFFERENCES ARE NOT CRITICAL BECAUSE THEY ARE NOT IN THE LOW-TO-MEDIUM SPEED RANGES, ONLY SHOWING UP NOTICEABLY WHEN THE CLOCK EXCEEDS 700 Hz.

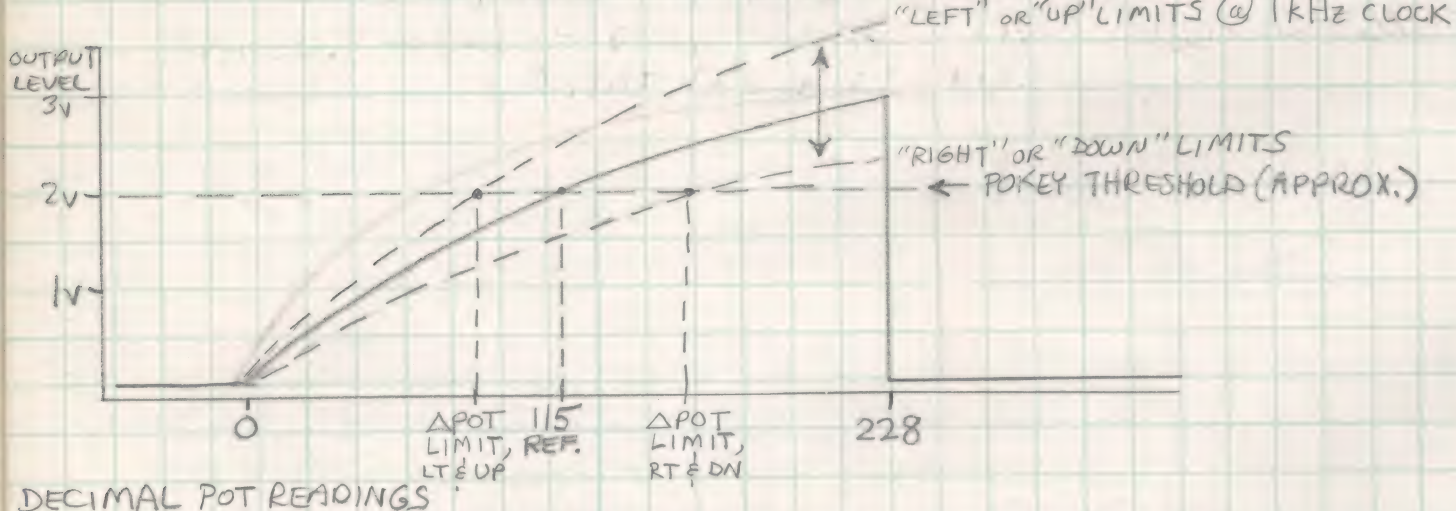

FIG. 5 RAMP RESPONSE WAVEFORM

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GAME OR PROJECT
CX53 TRAKBALL TEST REQUIREMENTS

E] RAMP RESPONSE TO LOW-SPEED CLOCK FREQUENCIES (UP TO ABOUT 200 Hz) WILL PRODUCE SOME NOTICEABLE RIPPLE ON THE WAVEFORM, BUT IS NOT EXCESSIVELY DETRIMENTAL TO THE EFFECTIVE FUNCTION. DATA CAN BE TAKEN IN 100 Hz STEPS UP TO 1kHz TO DETERMINE PERFORMANCE, MONITORING ΔPOT FOR EACH AXIS IN EACH DIRECTION. COMPARISON OF ΔPOT "LEFT" AND ΔPOT "RIGHT" WILL SHOW HOW CLOSE THE CONTROLLED OBJECT ON THE SCREEN WILL RETURN TO ITS ORIGINAL POSITION ON THE X AXIS WHEN THE BALL IS SPUN BACK AND FORTH AT APPROXIMATELY THE SAME SPEED. THIS SHOULD BE DONE FOR THE FULL RANGE OF CLOCK FREQUENCIES. LIKEWISE FOR ΔPOT "UP" & ΔPOT "DOWN." IF THE OPPOSITE-DIRECTION READINGS FOR EACH AXIS COMPARE WITHIN SPEC. LIMITS, AND THE ABSOLUTE VALUE LEVELS FOR ΔPOT COMPARE SIMILARLY BETWEEN THE TWO AXES, THEN CORRECT RESPONSE FOR X-Y TRAKBALL RESPONSE WILL BE ACHIEVED. THE END RESULT OF THIS ACCURATE ALIGNMENT IN OUTPUTS CAN BE SEEN IN MissileCommand WHEN USING THE TRAKBALL TO DESCRIBE CIRCLES WITH THE CURSOR: IT WILL MOVE IN A CIRCLE, NOT AN OVAL, AND WILL REMAIN IN ITS ORIGINAL STARTING AREA ON THE SCREEN. IF X-Y RESPONSE IS NOT LINEAR AND PROPORTIONAL, THE CURSOR WILL EVENTUALLY TEND TO DRIFT AWAY FROM ITS AREA OF ORIGIN [UNACCEPTABLE].

WRITER DK	DATE 11/10	WITNESS	DATE

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GAME OR PROJECT: CX53 TRAKBALL TEST REQUIREMENTS

TRAKBALL CALIBRATION CHECK

VOLTAGE @ C7 & C8 → VSTAT X = 3.70 V Y = 3.70

STATIC: X = 116 Y = 125

X ONE-SHOT = 1.1 msec

Y ONE SHOT = 1.1 msec

FIG. 6
TYPICAL ANALOG TRAKBALL PERFORMANCE

f = 100 Hz	ΔXRT		ΔXLT		ΔYDN		ΔYUP	
	+6	3.58	-8	3.88	+6	3.58	-8	3.88
200	+9	3.53	-11	3.94	+9	3.54	-11	3.94
300	+13	3.46	-15	4.06	+13	3.46	-15	4.04
400	+17	3.39	-19	4.15	+17	3.40	-18	4.12
500	+21	3.32	-22	4.26	+22	3.33	-22	4.23
600	+26	3.26	-25	4.35	+27	3.26	-25	4.32
700	+31	3.19	-28	4.45	+32	3.20	-29	4.41
800	+37	3.12	-30	4.55	+38	3.14	-31	4.50
900	+41	3.07	-32	4.62	+44	3.07	-34	4.61

VOLTAGE DECREASES & INCREASES AT C7 & C8 FROM VSTAT LEVEL, CORRESPONDING TO CHANGES IN ANALOG DRIVE ON POT LINES.

F OUTPUT RESPONSE PERFORMANCE REQUIREMENTS:

BASED ON CUMULATIVE HARD DATA GATHERED FROM NUMEROUS PROTOTYPE TRAKBALLS, THE EXPECTED RESPONSE SHOULD FALL WITHIN THESE LIMITS:

FOR CLOCK FREQ. 0-600 Hz: VARIATION ≤ 3 BETWEEN ABSOLUTE VALUE OF THE 2 ΔPOT READINGS FOR EACH AXIS

FOR CLOCK FREQ. 600-800 Hz: VARIATION ≤ 8

FOR CLOCK FREQ. 800-1 kHz: VARIATION ≤ 12

SEE FIG. 6 ABOVE FOR TABLE OF TYPICAL TRAKBALL PERFORMANCE.

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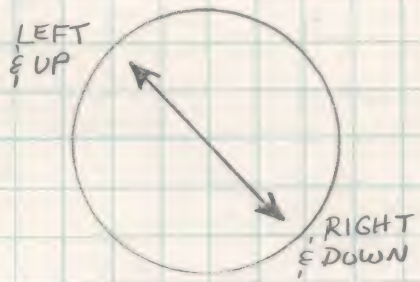
GAME OR PROJECT
CX53 TRAKBALL TEST REQUIREMENTS

[G] POSSIBLE FORMATS FOR CHECKING ANALOG RESPONSE:

① INPUT A CONTROLLED-FREQUENCY PULSED SIGNAL TO THE A3 ONE-SHOTS BY EITHER OF 2 METHODS:
→ BALL-GENERATED USING DC STEPPER MOTOR TO DRIVE BALL EACH DIRECTION, 100Hz STEPS TO 1kHz
→ TAP INTO EACH A3 INPUT (PINS 4 & 12) USING A WAVE-FORM GENERATOR AND INJECT THE PULSED SIGNAL. THE BALL COULD STILL BE USED TO CHANGE THE DIRECTION SIGNAL.

② MONITOR X&Y OUTPUTS, TAKE STATIC READINGS WITH NO INPUTS TO CIRCUIT

BALL TOP VIEW



WRITER	DATE	WITNESS	DATE
DJC	11/12		

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GAME OR PROJECT
CX53 TRAKBALL 1st ARTICLE PLASTIC REVELATIONS

PCB: ① SWAP OPTOCOUPLER LEAD-INS FOR BOTH AXES
② ADD GND. TEST-POINT (ALONG FRONT EDGE, RT. CORNER) (TP13)
③ CUT OFF RT-ANGLE CORNER 1/4" ON LOWER LT. CORNER
④ RELOCATE TP6 OUT FROM BETWEEN IC's A1-A2, TP7 ALSO
⑤ 3 MTG. HOLES TOO BIG NOW (REV. B) - BOARD RATTLES AROUND
IT WAS FINE 'TIL IT GOT CHANGED - WHO REQUESTED IT?
⑥ CORRECT SILKSCREEN:
a) RELABEL U1, U2, R1-4, R23, R24
b) RELABEL CIRCLED REF DES's RIGHT-SIDE UP
c) RELABEL ALL TEST POINTS HORIZONTALLY
d) RELOCATE TP6 & TP7
e) ADD TP13

CABLE: ① SWITCH RED & BRN WIRES ON 5 PIN CONNECTOR OR SWAP LINES ON PCB TO J2 PINS 4 & 5

(MECHANICAL)
PLASTIC: ① NARROW DOWN FIRE BUTTON CHANNELS IF POSSIBLE
② NEEDS CHAMFER AROUND BALL
③ BOARD SITS TOO HIGH FOR MECH. POSITIONING OF OPTOCOUPLER
A) J2 PINS HIT PLASTIC
B) A1, A2, AS SOCKET PINS SEVERAL THOU. TOO LONG (IN PLASTIC)
④ KEYPAD BUTTONS A LITTLE TOO RECESSED
⑤ PCB NOT HELD SECURELY ENOUGH
⑥ FIRE BUTTONS TOO WOBBLY
ELECTRICAL: ① CHANGE SCHEMATIC TO SHOW CORRECT COUPLER LEAD-INS
② RENUMBER KEYBOARD PINOUTS ON SCH.
③ PINS FOR J2 CONNECTOR MUST BE TRIMMED TO < .060
④ REDRAW PCB SUB-ASSY W/ CORRECTIONS FOR SILKSCREEN ABOVE

MORE MECHANICAL:
① KEYPAD BUTTONS NOT PROTRUDING ENOUGH TO ALLOW OVERLAYS TO WORK
② CORD WRAP TABS WON'T KEEP 2nd WIND OF CABLE IN PLACE (POSITION?)
③ CAN CLEARANCE AROUND ALL RUBBER KEYS BE REDUCED?

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GAME OR PROJECT

CX53 TRAK BALL UPPER PCB 1st ARTICLE (2) CARBON & SILVER EPOXY SINGLE-SIDED

D CARBON DEPOSITED W/ SILVER EPOXY SCREENED JUMPERS

(20) 60-40 WHEELS TO

WRITER	DATE	WITNESS	DATE
DK	11/30		

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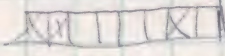
GAME OR PROJECT: STELLA

NTSC: 262 LINES/SCREEN: 192 VISIBLE (SCREEN)
40 VERT BLANKING (3 FOR VERT SYNC)
(READ @ 60Hz RATE) 30 OVERSCAN

STELLA CLOCK GIVES 76 CYCLES PER LINE; SCREEN:
V BLANK: 3040
OVERSC.: 2280

HORIZ. BLANK PERIOD: USED TO CHANGE COLOR, GRAPHICS (23 CYCLES LONG)

IN RAM, $00-2C = TIA WRITE REGISTERS
$00 = VSYNC, $01 = VBLANK



D6, D7 FOR LATCHES, GROUNDING PORTS

$02 = WAIT SYNC

Kernel:
PART OF PROGRAM USED TO SHOW IMAGE ON SCREEN

SCREEN DRAWING

PLAYFIELD: 40 PARTS, 4 PIXELS WIDE EA., CAN'T MOVE, LOW RESOLUTION

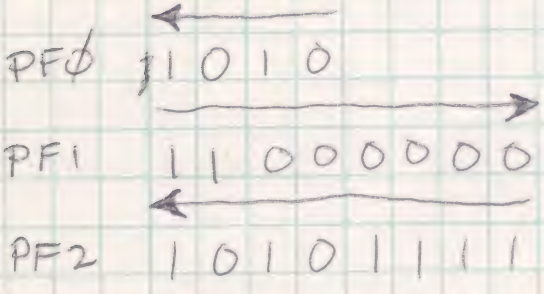
PLAYERS (2) [P0, P1] } PAIRED, SAME COLORS
MISSILES (2) [M0, M1] }

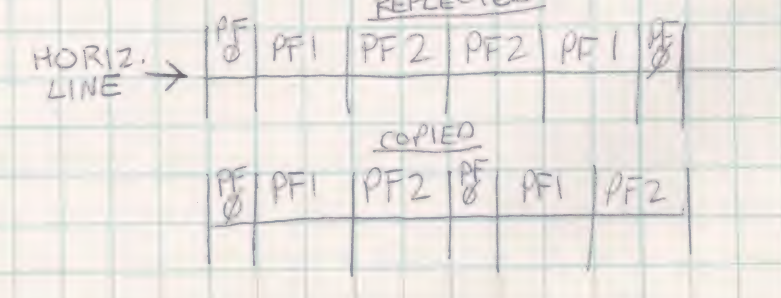
BALL - SAME COLOR AS PLAYFIELD

BACKGROUND

160 PIXELS ACROSS SCREEN

PLAYFIELD REGISTERS
PF0: USES ONLY HI-ORDER NIBBLE
PF1, PF2: USE ENTIRE BYTE





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GAME OR PROJECT: STELLA

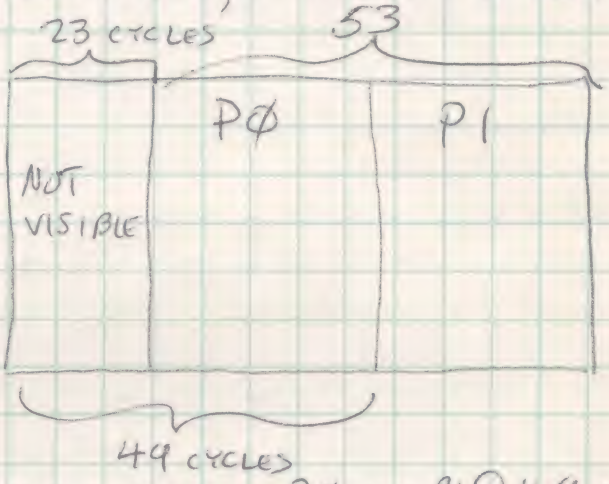
CTRLPF (CONTROL PLAYFIELD)

X	X	D5	D4	X	D2	D1	D0

D0 = 1: PLAYFIELD REFLECTED
D0 = 0: PLAYFIELD COPIED

D5 D4: CONTROL BALL WIDTH
D2: PLAYFIELD PRIORITY
SCORE: D1 = 1, P0 LEFT HALF, P1 RT. HALF OF PLAYFIELD

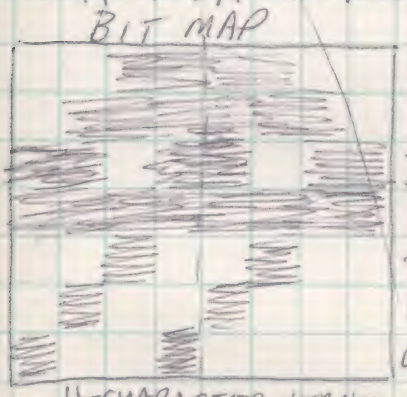
		D2 = 0	D2 = 1
1 CLOCK	00	P0 - M0	PF - BL
2 "	01	P1 - M1	P0 - M0
4 "	10	PF - BL	P1 - M1
8 "	11	BAK	BAK



MUST CHANGE P0 TO P1 @ 49 CYCLES TO GIVE CLEAN TRANSITION

PLAYERS (2): 8-WIDE BIT MAPS
MISSILES (2) } CAN ONLY CHANGE WIDTH
BALL (1) }

TO ACTIVATE PLAYER, STORE 1 IN GRP0 OR GRP1 REGISTERS



NUSIZ0, NUSIZ1 DETERMINE SIZE OF PLAYER

X	X	D5	D4	X	D2	D1	D0

D5 D4: MISSILE WIDTH, SAME AS BALL CONTROL:
1 CK = 00
2 = 01
4 = 10
8 = 11

000	1 COPY PLAYER	[8]
001	2 COPIES (CLOSE)	[8] 8 [8]
010	2 " (MEDIUM)	[8] 24 [8]
011	3 " (CLOSE)	[8] 8 [8] 8 [8]
100	2 " (WIDE)	[8] 56 [8]
101	DOUBLE WIDTH	[16]
110	3" (MEDIUM)	[8] 24 [8] 24 [8]
111	4 (QUAD WIDTH)	[32]

KNOCK OUT MIDDLE
KNOCK OUT MIDDLE

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JK	2/4		

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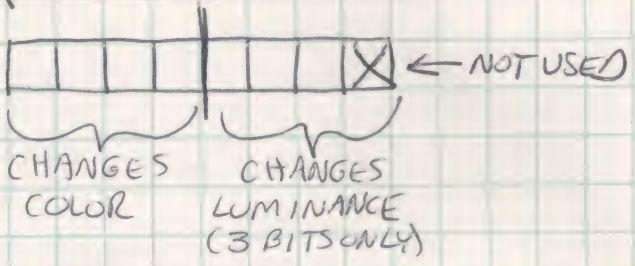
GAME OR PROJECT STELLA

COLU P0
P1
PF
BK



WRITER	DK	DATE 2/4	WITNESS	DATE

2/11

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GAME OR PROJECT

WRITER	DATE	WITNESS	DATE

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GAME OR PROJECT PAM

ONE LINE 114 CYCLES (VS. 76 IN STELLA)

V SYNC
V BLANK
W SYNC

DIRECT MEMORY ACCESS } 2nd PROCESSOR IN PAM

6 CHARACTER MODES, 8 MEMORY MAP MODES

GRAPHICS MODE 0: 40 CHARACTERS/LINE, 2 COLORS, 8 SCAN LINES IN HEIGHT (7 TALL W/ SPACE)

(C) ALSO: 40-2-16 (OR 10), 40-4-8, 40-4-16, 20-5-8, 20-5-16
(5TH COLOR IS BACKGND (ABSENCE OF COLOR))

1 BYTE/CHARACTER IN 2-COLOR MODE, 6 BITS ONLY
ALL 8 BITS FOR 4/5 COLORS

(M) 40-2-8, 80-2-4, 80-4-4, 160-2-2, 160-2-1, 160-4-2, 160-4-1, 320-2-1

40-2-8 :	5 BYTES OF DATA FOR	8 LINES	
80-2-4 :	10 "	4 "	MUST ADD UP TO 262 LINES
80-4-4 :	20 "	4 "	TO FILL SCREEN ACROSS
160-2-2 :	20 "	2 "	BEFORE HORIZ. RESET
160-2-1 :	20 "	1 "	
160-4-2 :	40 "	2 "	
160-4-1 :	40 "	1 "	
320-2-1 :	40 "	1 "	

DMA FUNCTIONS

LOAD MEMORY SCAN (BIT 6): GO TO SPEC. LOCATION, LOAD NEXT SET OF BYTES TO GIVE A LINE ON SCREEN

HORIZ. SCROLL (BIT 4): MAKES PLAYFIELD SHIFT SIDE TO SIDE

VERT. SCROLL (BIT 5): MAKES PLAYFIELD SHIFT TOP TO BOTTOM

INTERRUPT (BIT 7): JUMP OUT OF CURRENT ROUTINE, GO TO SIDE TRIP

PLAYER: STRING OF 256 BYTES : PAM HAS 4, 8 BITS WIDE EACH
MISSILE: " " " " : PAM HAS 4, 2 BITS WIDE EACH
MISSILES CAN BE BUNCHED TOGETHER INTO ONE BYTE TO CREATE A 5TH MISSILE

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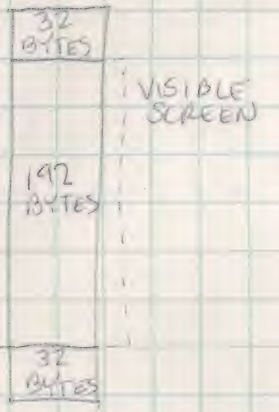
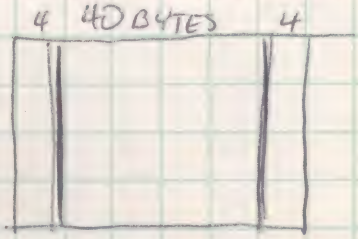
DK	1/28		

GAME OR PROJECT: POM



SIZE P0 - SIZE P3 (CLOCKS)
2 CONTROL BITS:
00 : 8 CLOCKS
01 : 16
10 : 8
11 : 32

SCROLLING



DMA INSTRUCTIONS:

INSTRUCTION — 1 OR 3 CYCLES
PLAYERS, MISSILES — 0-5 CYCLES
PLAYFIELD — 0, 20, 24, 40, 48 "
REFRESH — UP TO 9 CYCLES

DMACTL (6 BITS WIDE) [DMA CONTROL]

X	X	D5	D4	D3	D2	D1	D0

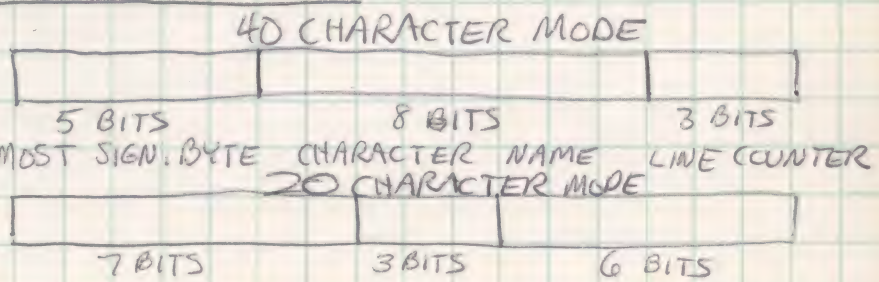
D5: ENABLE INSTRUCTION FETCH
D4: 1 = SINGLE LINE RESOLUTION, 0 = 2 LINE RES.
D3: ENABLE PLAYER DMA
D2: ENABLE MISSILE DMA
D1 D0:
00 : NO PLAYFIELD
01 : NARROW PF (128 CLOCKS)
10 : NORMAL PF (160 CLOCKS)
11 : WIDE (SCROLL) PF (192 CLOCKS)

CHACTL (3 BITS WIDE) [CHARACTER CONTROL]

X	X	X	X	X	D2	D1	D0

D2: VERT REFLECT
D1: VIDEO (COLOR) INVERSION
D0: BLANK

CHBASE (16 BITS)
COMPOSITE CONTROL REGISTER



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GAME OR PROJECT POM

PMBASE

KBCODE: MEM LOCATION CONTAINS # OF FOR EACH OF THE KEYBOARD BUTTONS (BUTTN0-BUTTNF)

```
LDA   KBCODE
LSR   A          (LEFT SHIFT - KBCODE * 2)  00 - 1E BY TWOS
TAX              (PUT A INTO X)
LDA   BTNTBL,X   (FROM BUTTN TABLE)
STA   JMPPTR
LDA   BTNTBL+1,X
STA   JMPPTR+1
JMP   (JMPPTR)
```

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ENGINEERING LOG SHEET

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GAME OR PROJECT

WRITER	DATE	WITNESS	DATE

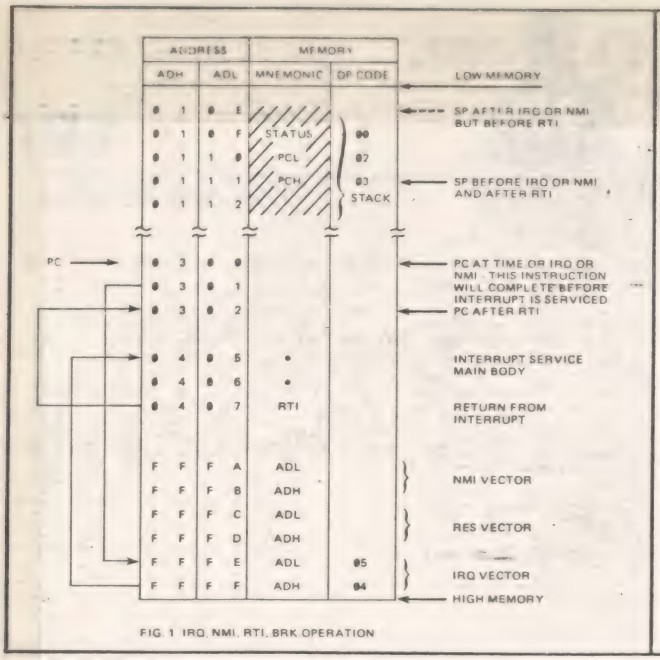


FIG. 1 IRQ, NMI, RTI, BRK OPERATION

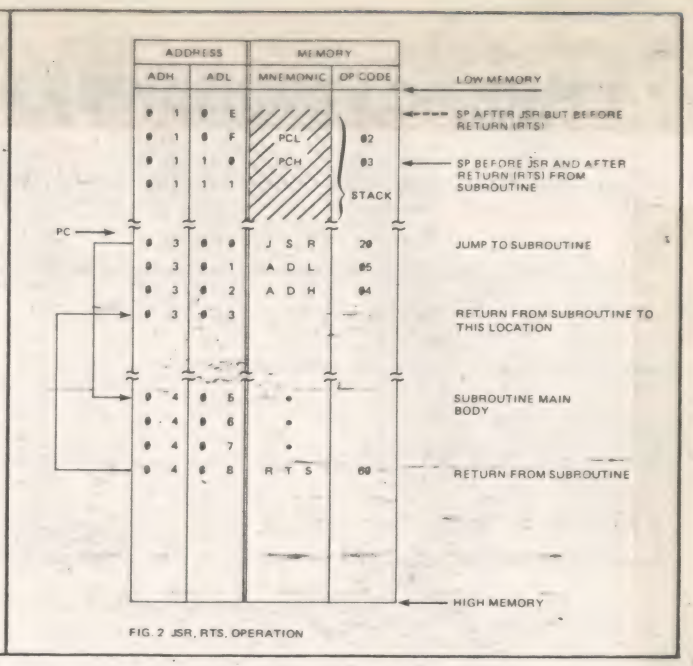


FIG. 2 JSR, RTS, OPERATION

ASSEMBLER DIRECTIVES

- OPT – SPECIFIES OPTIONS FOR ASSEMBLY
  OPTIONS ARE: (OPTIONS LISTED FIRST ARE THE DEFAULT VALUES).
  NOC (COU OR CNT) – DO NOT LIST ALL INSTRUCTIONS AND THEIR USAGE.
  NOG (GEN) – DO NOT GENERATE MORE THAN ONE LINE OF CODE FOR ASCII STRINGS.
  XRE (NOX) – PRODUCE A CROSS-REFERENCE LIST IN THE SYMBOL TABLE.
  ERR (NOE) – CREATE AN ERROR FILE.
  MEM (NOM) – CREATE AN ASSEMBLER OBJECT OUTPUT FILE.
  LIS (NOL) – PRODUCE A FULL ASSEMBLY LISTING.
- BYTE – PRODUCES A SINGLE BYTE IN MEMORY EQUAL TO EACH OPERAND SPECIFIED.
- WORD – PRODUCES AN ADDRESS (2 BYTES) IN MEMORY EQUAL TO EACH OPERAND SPECIFIED.
- DBYTE – PRODUCES TWO BYTES IN MEMORY EQUAL TO EACH OPERAND SPECIFIED.
- SKIP – GENERATE THE NUMBER OF BLANK LINES SPECIFIED BY THE OPERAND.
- PAGE – ADVANCE THE LISTING TO THE TOP OF A NEW PAGE AND CHANGE TITLE.
- END – DEFINES THE END OF A SOURCE PROGRAM.
- * = – DEFINES THE BEGINNING OF A NEW PROGRAM COUNTER SEQUENCE.

LABELS

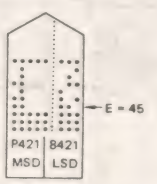
LABELS ARE THE FIRST FIELD AND MUST BE FOLLOWED BY AT LEAST ONE SPACE.
LABELS CAN BE UP TO 6 ALPHANUMERIC CHARACTERS LONG AND MUST BEGIN WITH AN ALPHA CHARACTER.
A,X,Y,S,P AND THE 56 OPCODES ARE RESERVED AND CANNOT BE USED AS LABELS.
LABEL = EXPRESSION CAN BE USED TO EQUATE LABELS TO VALUES.
LABEL *=* +N CAN BE USED TO RESERVE AREAS IN MEMORY.

CHARACTERS USED AS SPECIAL PREFIXES:

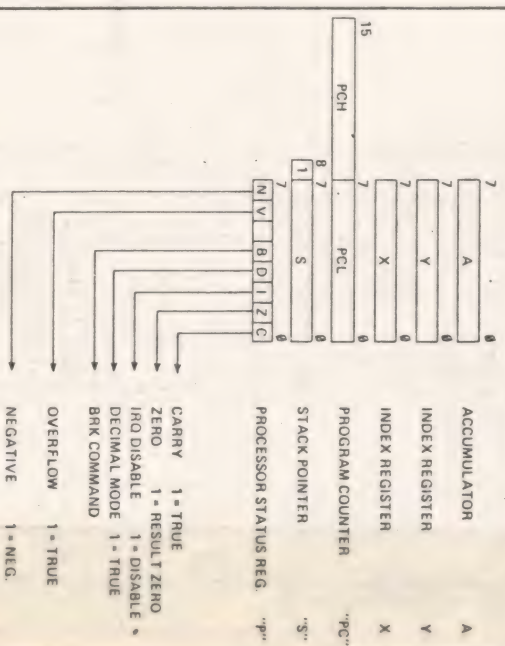
- • INDICATES AN ASSEMBLER DIRECTIVE
- # SPECIFIES THE IMMEDIATE MODE OF ADDRESSING
- $ SPECIFIES A HEXADECIMAL NUMBER
- @ SPECIFIES AN OCTAL NUMBER
- % SPECIFIES A BINARY NUMBER
- ' SPECIFIES AN ASCII LITERAL CHARACTER
- ( ) INDICATES INDIRECT ADDRESSING
- ; INDICATES FOLLOWING TEXT ARE COMMENTS
- < SPECIFIES LOWER HALF OF A 16 BIT VALUE
- > SPECIFIES UPPER HALF OF A 16 BIT VALUE

ASCII CHARACTER SET (7-BIT CODE)

LSD \ MSD	0 000	1 001	2 010	3 011	4 100	5 101	6 110	7 111
0	0000	NUL	DLE	SP	0	@	P	`	p
1	0001	SOH	DC1	!	1	A	Q	a	q
2	0010	STX	DC2	"	2	B	R	b	r
3	0011	ETX	DC3	#	3	C	S	c	s
4	0100	EOT	DC4	$	4	D	T	d	t
5	0101	ENG	NAK	%	5	E	U	e	u
6	0110	ACK	SYN	&	6	F	V	f	v
7	0111	BEL	ETB	'	7	G	W	g	w
8	1000	BS	CAN	(	8	H	X	h	x
9	1001	HT	EM	)	9	I	Y	i	y
A	1010	LF	SUB	*	:	J	Z	j	z
B	1011	VT	ESC	+	;	K	[	k	{
C	1100	FF	FS	,	<	L	\	l	|
D	1101	CR	GS	-	=	M	]	m	}
E	1110	SO	RS	.	>	N	↑	n	~
F	1111	SI	VS	/	?	O	←	o	DEL



PROCESSOR PROGRAMMING MODEL



SY6500 INSTRUCTION SET SUMMARY

Synertek®
P.O. Box 552, 95052
3001 Stender Way
Santa Clara, CA 95051
(408) 988-5616

INSTRUCTIONS		IMMEDIATE			ABSOLUTE			ZERO PAGE			ACCUM			IMPLIED			(IND, X)			(IND), Y			Z, PAGE, X			ABS, X			ABS, Y			RELATIVE			INDIRECT			Z, PAGE, Y			CONDITION CODES					
MNEMONIC	OPERATION	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	N	Z	C	I	D	V
ADC	A + M + C → A (4)	(1) 69	2	2	6D	4	3	65	3	2							61	6	2	71	5	2	75	4	2	7D	4	3	79	4	3										✓	✓	✓	–	–	✓
AND	A ∧ M → A	(1) 29	2	2	2D	4	3	25	3	2							21	6	2	31	5	2	35	4	2	3D	4	3	39	4	3										✓	✓	–	–	–	–
ASL	C ← [7 0] ← 0				0E	6	3	06	5	2	0A	2	1										16	6	2	1E	7	3													✓	✓	✓	–	–	–
BCC	BRANCH ON C=0	(2)																															90	2	2							–	–	–	–	–	–
BCS	BRANCH ON C=1	(2)																															B0	2	2							–	–	–	–	–	–
BEQ	BRANCH ON Z=1	(2)																															F0	2	2							–	–	–	–	–	–
BIT	A ∧ M				2C	4	3	24	3	2																																M_7	✓	–	–	–	M_6
BMI	BRANCH ON N=1	(2)																															30	2	2							–	–	–	–	–	–
BNE	BRANCH ON Z=0	(2)																															D0	2	2							–	–	–	–	–	–
BPL	BRANCH ON N=0	(2)																															10	2	2							–	–	–	–	–	–
BRK	(See Fig. 1)													00	7	1																									–	–	–	–	–	–
BVC	BRANCH ON V=0	(2)																															50	2	2							–	–	–	–	–	–
BVS	BRANCH ON V=1	(2)																															70	2	2							–	–	–	–	–	–
CLC	0 → C													18	2	1																									–	–	0	–	–	–
CLD	0 → D													D8	2	1																									–	–	–	–	0	–
CLI	0 → I													58	2	1																									–	–	–	0	–	–
CLV	0 → V													B8	2	1																									–	–	–	–	–	0
CMP	A-M	(1) C9	2	2	CD	4	3	C5	3	2							C1	6	2	D1	5	2	D5	4	2	DD	4	3	D9	4	3										✓	✓	✓	–	–	–
CPX	X-M	E0	2	2	EC	4	3	E4	3	2																															✓	✓	✓	–	–	–
CPY	Y-M	C0	2	2	CC	4	3	C4	3	2																															✓	✓	✓	–	–	–
DEC	M-1 → M				CE	6	3	C6	5	2													D6	6	2	DE	7	3													✓	✓	–	–	–	–
DEX	X-1 → X													CA	2	1																									✓	✓	–	–	–	–
DEY	Y-1 → Y													88	2	1																									✓	✓	–	–	–	–
EOR	A ⊻ M → A	(1) 49	2	2	4D	4	3	45	3	2							41	6	2	51	5	2	55	4	2	5D	4	3	59	4	3										✓	✓	–	–	–	–
INC	M+1 → M				EE	6	3	E6	5	2													F6	6	2	FE	7	3													✓	✓	–	–	–	–
INX	X+1 → X													E8	2	1																									✓	✓	–	–	–	–
INY	Y+1 → Y													C8	2	1																									✓	✓	–	–	–	–
JMP	JUMP TO NEW LOC				4C	3	3																													6C	5	3				–	–	–	–	–	–
JSR	(See Fig. 2) JUMP SUB				20	6	3																																		–	–	–	–	–	–
LDA	M → A	(1) A9	2	2	AD	4	3	A5	3	2							A1	6	2	B1	5	2	B5	4	2	BD	4	3	B9	4	3										✓	✓	–	–	–	–

INSTRUCTIONS		IMMEDIATE			ABSOLUTE			ZERO PAGE			ACCUM			IMPLIED			(IND, X)			(IND), Y			Z, PAGE, X			ABS, X			ABS, Y			RELATIVE			INDIRECT			Z, PAGE, Y			CONDITION CODES					
MNEMONIC	OPERATION	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	N	Z	C	I	D	V
LDX	M → X	(1) A2	2	2	AE	4	3	A6	3	2																			BE	4	3										B6	4	2	✓	✓	–	–	–	–
LDY	M → Y	(1) A0	2	2	AC	4	3	A4	3	2																																	✓	✓	–	–	–	–
LSR	0 → [7 0] → C				4E	6	3	46	5	2	4A	2	1										56	6	2	5E	7	3													0	✓	✓	–	–	–
NOP	NO OPERATION													EA	2	1																									–	–	–	–	–	–
ORA	A ∨ M → A	09	2	2	0D	4	3	05	3	2							01	6	2	11	5	2	15	4	2	1D	4	3	19	4	3										✓	✓	–	–	–	–
PHA	A → Ms S-1 → S													48	3	1																									–	–	–	–	–	–
PHP	P → Ms S-1 → S													08	3	1																									–	–	–	–	–	–
PLA	S+1 → S Ms → A													68	4	1																									✓	✓	–	–	–	–
PLP	S+1 → S Ms → P													28	4	1																									(RESTORED)					
ROL	[7 0] ← [C] ←				2E	6	3	26	5	2	2A	2	1										36	6	2	3E	7	3													✓	✓	✓	–	–	–
ROR	→ [C] → [7 0]				6E	6	3	66	5	2	6A	2	1										76	6	2	7E	7	3													✓	✓	✓	–	–	–
RTI	(See Fig. 1) RTRN INT.													40	6	1																									(RESTORED)					
RTS	(See Fig. 2) RTRN SUB													60	6	1																									–	–	–	–	–	–
SBC	A-M-$\overline{C}$ → A	(1) E9	2	2	ED	4	3	E5	3	2							E1	6	2	F1	5	2	F5	4	2	FD	4	3	F9	4	3										✓	✓	(3)	–	–	✓
SEC	1 → C													38	2	1																									–	–	1	–	–	–
SED	1 → D													F8	2	1																									–	–	–	–	1	–
SEI	1 → I													78	2	1																									–	–	–	1	–	–
STA	A → M				8D	4	3	85	3	2							81	6	2	91	6	2	95	4	2	9D	5	3	99	5	3										–	–	–	–	–	–
STX	X → M				8E	4	3	86	3	2																															96	4	2	–	–	–	–	–	–
STY	Y → M				8C	4	3	84	3	2													94	4	2																	–	–	–	–	–	–
TAX	A → X													AA	2	1																									✓	✓	–	–	–	–
TAY	A → Y													A8	2	1																									✓	✓	–	–	–	–
TSX	S → X													BA	2	1																									✓	✓	–	–	–	–
TXA	X → A													8A	2	1																									✓	✓	–	–	–	–
TXS	X → S													9A	2	1																									–	–	–	–	–	–
TYA	Y → A													98	2	1																									✓	✓	–	–	–	–

(1) ADD 1 TO "N" IF PAGE BOUNDARY IS CROSSED
(2) ADD 1 TO "N" IF BRANCH OCCURS TO SAME PAGE
ADD 2 TO "N" IF BRANCH OCCURS TO DIFFERENT PAGE
(3) CARRY NOT = BELOW
(4) IF IN DECIMAL MODE Z FLAG IS INVALID
ACCUMULATOR MUST BE CHECKED FOR ZERO RESULT

X INDEX X
Y INDEX Y
A ACCUMULATOR
M MEMORY PER EFFECTIVE ADDRESS
Ms MEMORY PER STACK POINTER

+ ADD
– SUBTRACT
∧ AND
∨ OR
⊻ EXCLUSIVE OR
✓ MODIFIED

– NOT MODIFIED
M_7 MEMORY BIT 7
M_6 MEMORY BIT 6
N NO. CYCLES
= NO. BYTES

OP-CODE TABLE

LSD / MSD	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	LSD / MSD
0	BRK	ORA-IND, X				ORA-Z, Page	ASL-Z, PAGE		PHP	ORA-IMM	ASL-A			ORA-ABS	ASL-ABS		0
1	BPL	ORA-IND, Y				ORA-Z, Page, X	ASL-Z, Page, X		CLC	ORA-ABS, Y				ORA-ABS, X	ASL-ABS, X		1
2	JSR	AND-IND, X			BIT-Z, Page	AND-Z, Page	ROL-Z, Page		PLP	AND-IMM	ROL-A		BIT-ABS	AND-ABS	ROL-ABS		2
3	BMI	AND-IND, Y				AND-Z, Page, X	ROL-Z, Page, X		SEC	AND-ABS, Y				AND-ABS, X	ROL-ABS, X		3
4	RTI	EOR-IND, X				EOR-Z, Page	LSR-Z, Page		PHA	EOR-IMM	LSR-A		JMP-ABS	EOR-ABS	LSR-ABS		4
5	BVC	EOR-IND, Y				EOR-Z, Page, X	LSR-Z, Page, X		CLI	EOR-ABS, Y				EOR-ABS, X	LSR-ABS, X		5
6	RTS	ADC-IND, X				ADC-Z, Page	ROR-Z, Page		PLA	ADC-IMM	ROR-A		JMP-IND	ADC-ABS	ROR-ABS		6
7	BVS	ADC-IND, Y				ADC-Z, Page, X			SEI	ADC-ABS, Y				ADC-ABS, X			7
8		STA-IND, X			STY-Z, Page	STA-Z, Page	STX-Z, Page		DEY		TXA		STY-ABS	STA-ABS	STX-ABS		8
9	BCC	STA-IND, Y			STY-Z, Page, X	STA-Z, Page, X	STX-Z, Page, Y		TYA	STA-ABS, Y	TXS			STA-ABS, X			9
A	LDY-IMM	LDA-IND, X	LDX-IMM		LDY-Z, Page	LDA-Z, Page	LDX-Z, Page		TAY	LDA-IMM	TAX		LDY-ABS	LDA-ABS	LDX-ABS		A
B	BCS	LDA-IND, Y			LDY-Z, Page, X	LDA-Z, Page, X	LDX-Z, Page, Y		CLV	LDA-ABS, Y	TSX		LDY-ABS, X	LDA-ABS, X	LDX-ABS, Y		B
C	CPY-IMM	CMP-IND, X			CPY-Z, Page	CMP-Z, Page	DEC-Z, Page		INY	CMP-IMM	DEX		CPY-ABS	CMP-ABS	DEC-ABS		C
D	BNE	CMP-IND, Y				CMP-Z, Page, X	DEC-Z, Page, X		CLD	CMP-ABS, Y				CMP-ABS, X	DEC-ABS, X		D
E	CPX-IMM	SBC-IND, X			CPX-Z, Page	SBC-Z, Page	INC-Z, Page		INX	SBC-IMM	NOP		CPX-ABS	SBC-ABS	INC-ABS		E
F	BEQ	SBC-IND, Y				SBC-Z, Page, X	INC-Z, Page, X		SED	SBC-ABS, Y				SBC-ABS, X	INC-ABS, X		F

IMM - IMMEDIATE ADDRESSING – THE OPERAND IS CONTAINED IN THE SECOND BYTE OF THE INSTRUCTION.

ABS - ABSOLUTE ADDRESSING – THE SECOND BYTE OF THE INSTRUCTION CONTAINS THE 8 LOW ORDER BITS OF THE EFFECTIVE ADDRESS. THE THIRD BYTE CONTAINS THE 8 HIGH ORDER BITS OF THE EFFECTIVE ADDRESS.

Z. PAGE - ZERO PAGE ADDRESSING – SECOND BYTE CONTAINS THE 8 LOW ORDER BITS OF THE EFFECTIVE ADDRESS. THE 8 HIGH ORDER BITS ARE ZERO.

A. - ACCUMULATOR - ONE BYTE INSTRUCTION OPERATING ON THE ACCUMULATOR.

Z. PAGE, X - Z. PAGE, Y - ZERO PAGE INDEXED – THE SECOND BYTE OF THEINSTRUCTION IS ADDED TO THE INDEX (CARRY IS DROPPED) TO FORM THE LOW ORDER BYTE OF THE EA. THE HIGH ORDER BYTE OF THE EA IS ZEROS.

ABS. X ABS. Y ABSOLUTE INDEXED – THE EFFECTIVE ADDRESS IS FORMED BY ADDING THE INDEX TO THE SECOND AND THIRD BYTE OF THE INSTRUCTION.

(IND. X) - INDEXED INDIRECT – THE SECOND BYTE OF THE INSTRUCTION IS ADDED TO THE X INDEX, DISCARDING THE CARRY. THE RESULTS POINTS TO A LOCATION ON PAGE ZERO WHICH CONTAINS THE 8 LOW ORDER BITS OF THE EA. THE NEXT BYTE CONTAINS THE 8 HIGH ORDER BITS.

(IND). Y - INDIRECT INDEXED – THE SECOND BYTE OF THE INSTRUCTION POINTS TO A LOCATION IN PAGE ZERO. THE CONTENTS OF THIS MEMORY LOCATION IS ADDED TO THE Y INDEX, THE RESULT BEING THE LOW ORDER EIGHT BITS OF THE EA. THE CARRY FROM THIS OPERATION IS ADDED TO THE CONTENTS OF THE NEXT PAGE ZERO LOCATION, THE RESULTS BEING THE 8 HIGH ORDER BITS OF THE EA.

Suck 'Em up!

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ATARI® ENGINEERING LOG SHEET

GAME OR PROJECT 6502

8 BIT MICROPROCESSOR

BINARY D7 1 1 1 0 1 1 0 1 D0 : 256 DIFF. COMBOS

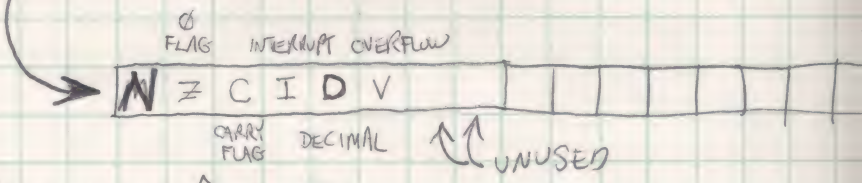
HEX $D7

HEX NOTATION

RAM & ROM & REGISTERS:

Thanx for the Memory!

A ACCUMULATOR
X INDEX
Y INDEX
P PROCESSOR



1 PAGE 256 BYTES

0000 - 00FF PAGE Ø
0100 - 01FF PAGE 1
FF00 - FFFF LAST PAGE

} RAM STACK, USES ON 6502, ALL ONE PAGE

ONE-BYTE STACK POINTER

GROUP 1 INSTRUCTIONS (ONLY GROUP W/ INDIRECT MODE)

MNEMONICS

STA: STORE FROM A ELSEWHERE
LDA: LOAD INTO A
CMP: COMPARE
AND: AND
ORA: OR
EOR: EXCLUSIVE OR
ADC: ADD W/ CARRY
SBC: SUBTRACT W/ CARRY

8 MODES

		BYTES / CYCLES
1	IMMEDIATE - EXECUTE INSTANTLY (FAST)	2/2
2	ZERO PAGE - QUICK ACCESS	2/3
3	ZERO PAGE, X - ADD X TO ZERO PAGE ADDRESS	2/4
4	ABSOLUTE - ANYTHING NOT FROM ZERO PAGE	3/4
5	ABSOLUTE, X - ADD X TO ABSOLUTE ADDRESS	3/4*
6	ABSOLUTE, Y - ADD Y TO " "	3/4*
7	(INDIRECT, X) - LOAD FROM ADDRESS OF 2 BYTES	2/6
8	(INDIRECT), Y - LOAD INDIRECT, ADD TO Y	2/5*

LDA IS NON-DESTRUCTIVE: DOESN'T DESTROY WHAT'S IN LOCATION THAT HOLDS INFO.

CMP: COMPARE A TO M & CHANGE PROCESSOR ACCORDINGLY

* TAKES ONE MORE IF CROSSING PAGE BOUNDARY

WRITER DK	DATE 2/3/82	WITNESS	DATE

GAME OR PROJECT: 6502

BCC : C = Ø JUMP 1/2 PAGE (128 BYTES) EITHER WAY (BRANCH ON CARRY CLEAR)
BCS : C = 1 (BRANCH ON CARRY SET)
BEQ : Z = 1 (BRANCH EQUAL)
BNE : Z = Ø (BRANCH NOT EQUAL)
BMI : N = 1 (BRANCH MINUS)
BPL : N = Ø (BRANCH PLUS)

```
CLC     C=0
LDA     POINT 1   (MEMORY ADDRESS LOCATION)
ADC     #$AB
STA     POINT 1
LDA     (POINT 1)+1
ADC     #0
STA     (POINT 1)+1
```

C = 0
A = ED
A = 98, C = 1

A = FE
C = 0, A = FF

CARRY
1
ED
AB
98

FE = POINT +1
ED = POINT

⇦ ADC

COMPLEMENTS:
$\bar{X}+1=-X$ $X+\bar{X}=-1$ $X+\bar{X}+1=Ø$
FF = ØØ + (-1)

```
SEC     C=1
LDA     POINT 1
SBC     #$AB
STA     POINT 1
LDA     POINT +1
SBC     #0
STA     POINT
```

C = 1
A = ED

⇦ SBC

EOR (⊻)
(EXCLUSIVE OR)

1 ⊻ 1 = 0
0 ⊻ 1 = 1 ⊻ 0 = 1
0 ⊻ 0 = 0

```
1011 | 0110
1010 | 1010
-----------
0001 | 1100
```

```
  1011 | 0110
∧ 1010 | 1010
---------------
1010 0010
```

⇦ AND (∧)

1 ∧ 1 = 1
1 ∧ 0 = 0 ∧ 1 = 0
0 ∧ 0 = 0

```
  1011 | 0110
∨ 1010 | 1010
---------------
1011 1110
```

⇦ ORA (∨)
(LOGICAL OR)

1 ∨ 1 = 1
1 ∨ 0 = 0 ∨ 1 = 1
0 ∨ 0 = 0

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GAME OR PROJECT: 6502

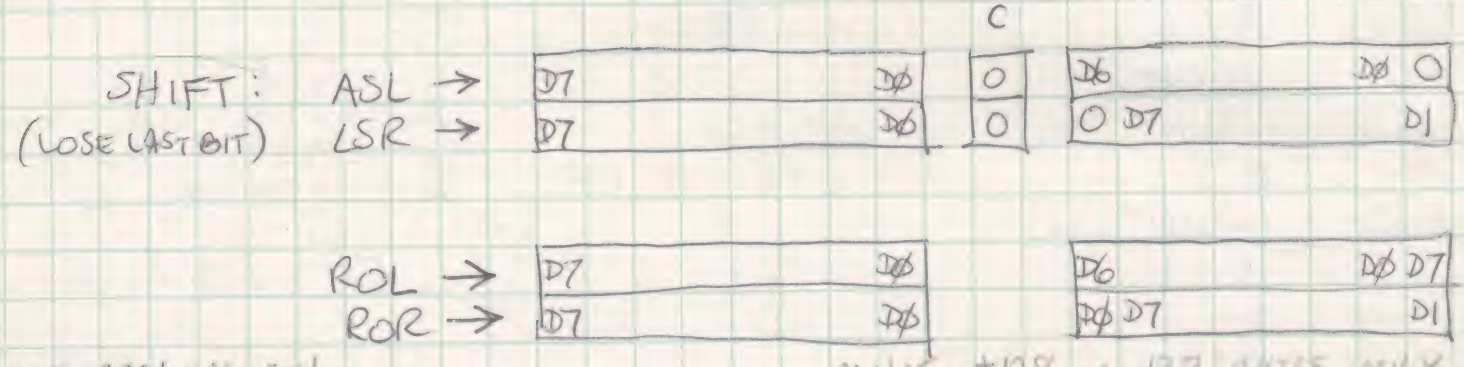
SHIFTS:

ASL - SHIFT LEFT
LSR - SHIFT RIGHT

ROTATE:

ROL - ROTATE LEFT
ROR - ROTATE RIGHT

	MODES:	BYTES/CYCLES
(1)	A	1/2
(2)	ZP	2/5
(3)	ZP, X	2/6
(4)	ABS	3/6
(5)	ABS, X	3/7



MOVE ANYWHERE!?

JMP DIRECT 3/3 BYTES/CYCLES

JMP INDIRECT 3/5
TAKES ADDRESS FOR DATA AS TO JMP LOCATION

JUMP SUBROUTINE

JSR: MULT 7,

Subroutines.

PCL, PCH: POINT TO 2 CURRENT BYTES IN P.C. STACK

MOVE +128 OR -127 BYTES ONLY

BNE BRANCH NOT EQUAL TRUE: 2/3 BYTES/CYCLES NOT TRUE 2/2

BEQ BRANCH EQUAL: DITTO

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DK	2/10		

GAME OR PROJECT 6502

INTERRUPTS

PC+1 ↑
PC+2 ↑

INTRPT PHA
TXA
PHA
TYA
PHA

BUTTON HANDLING CODE

MASKABLE: CAN BE IGNORED
NON-MASKABLE: MUST BE SERVICED (SUCH AS V BLANK)

PLA
TAY
PLA
TAX
PLA
RTI

WRITER	DATE	WITNESS	DATE

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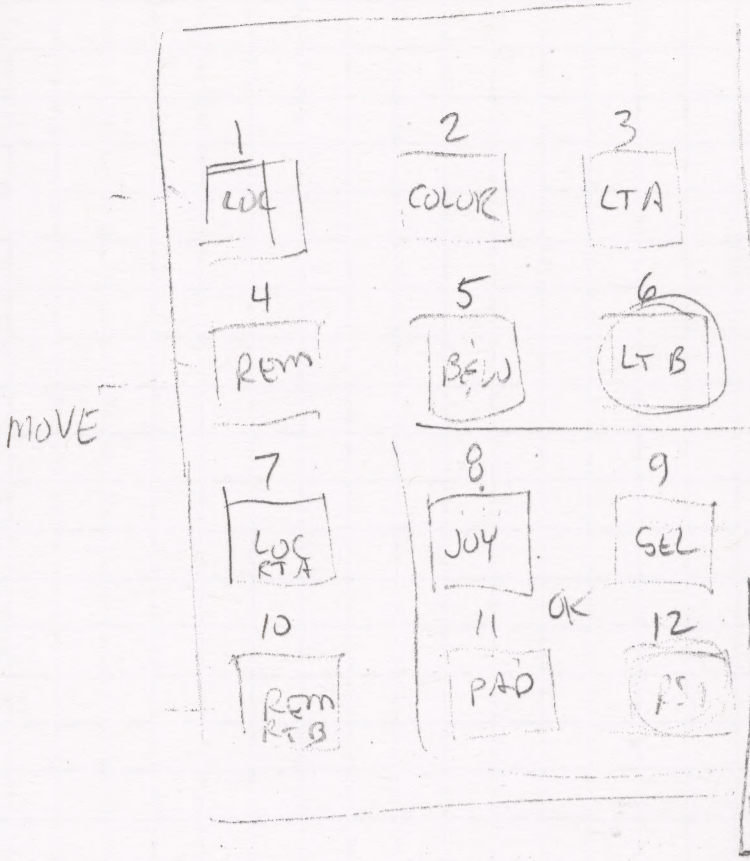
GAME OR PROJECT



KEYPAD		PCB	
COLOR	KEY#	FUNCTION	HEADER
GRN *	1 OK	LOCAL	9 OK
WHT/GRN #	2 OK	COLOR	8 OK
WHT/ORN #	3 OK	LEFT A	10 OK
RED * J	4 OK	REMOTE	2 OK
WHT/BLK #	5 OK	BEW	3 OK
BLK #	6 OK	LEFT B	4 OK
GREY #	7 OK	RIGHT A	11 OK
BRN * J	8 OK	JOYSTICK	12 OK
V10 *	9 OK	SELECT	13 OK
WHT/RED #	10 OK	RIGHT B	5 OK
WHT *	11 OK	PADDLE	6 OK
BLU * Jx2	12 OK	RESET	7 OK
YEL *	COM	GND	1
ORN *	COM	GND	1

SWAP ON PCB

CABLE WIRES:

* = CONNECTED TO PCB EDGE TERMINAL
\# = SOLDERED ONTO PCB

WRITER	DATE	WITNESS	DATE

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ENGINEERING LOG SHEET

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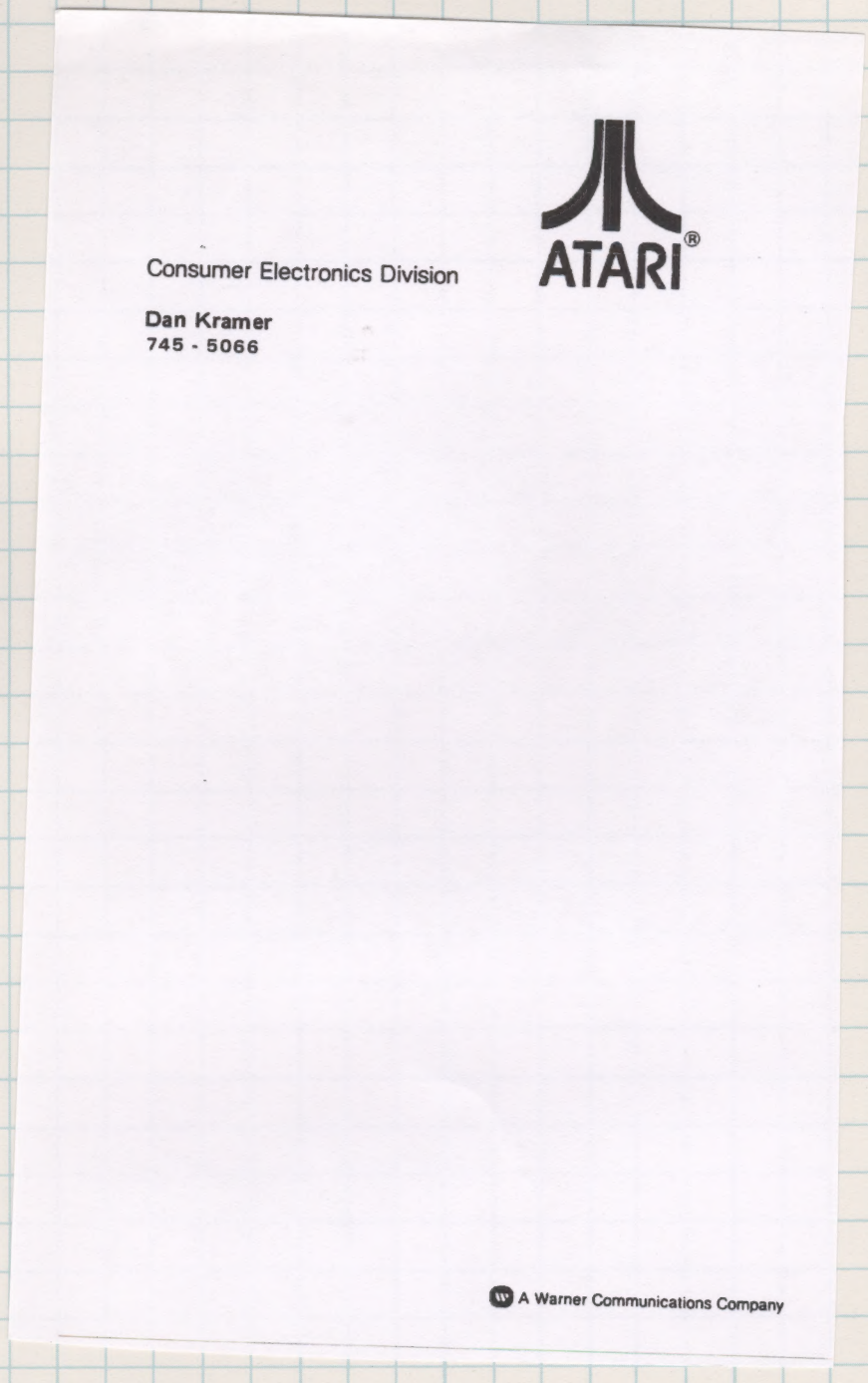
GAME OR PROJECT



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