

WRITE ADDRESS DETAILED FUNCTIONS

WSYNC

wait for sync

THIS ADDRESS HALTS MICROPROCESSOR BY CLEARING RDY LATCH TO ZERO. RDY IS SET TRUE AGAIN BY THE LEADING EDGE OF HORIZONTAL BLANK.

DATA BITS NOT USED

RSYNC

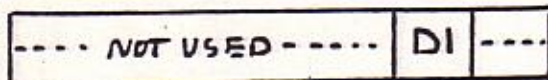
reset sync

THIS ADDRESS RESETS THE HORIZONTAL SYNC COUNTER TO DEFINE THE BEGINNING OF HORIZONTAL BLANK TIME, AND IS USED IN CHIP TESTING.

DATA BITS NOT USED

VSYNC

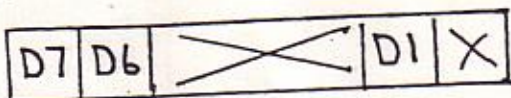
THIS ADDRESS CONTROLS VERTICAL SYNC TIME BY WRITING D1 INTO THE VSYNC LATCH.



1
0

START VERT. SYNC
STOP VERT. SYNC

VBLANK THIS ADDRESS CONTROLS VERTICAL BLANK AND THE LATCHES AND DUMPING TRANSISTORS ON THE INPUT PORTS BY WRITING INTO BITS D7, D6 AND D1 OF THE VBLANK REGISTER.



NOTE: ... SABLE LATCHES (D6=0) ALSO RESETS LATCHES TO LOGIC TRUE

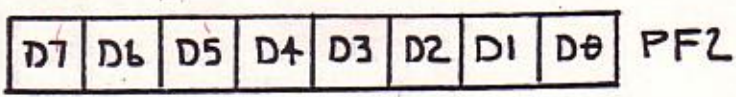
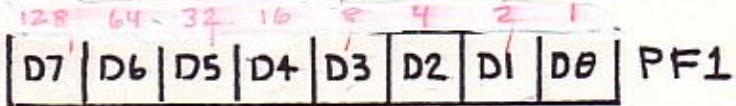
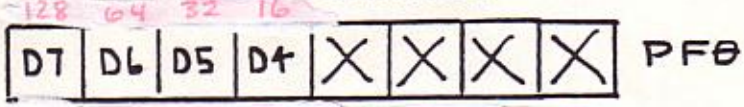
D1 { 1 START VERT. BLANK
0 STOP VERT. BLANK

D6 { 1 ENABLE I4 I5 LATCHES
0 ... SABLE I4 I5 LATCHES

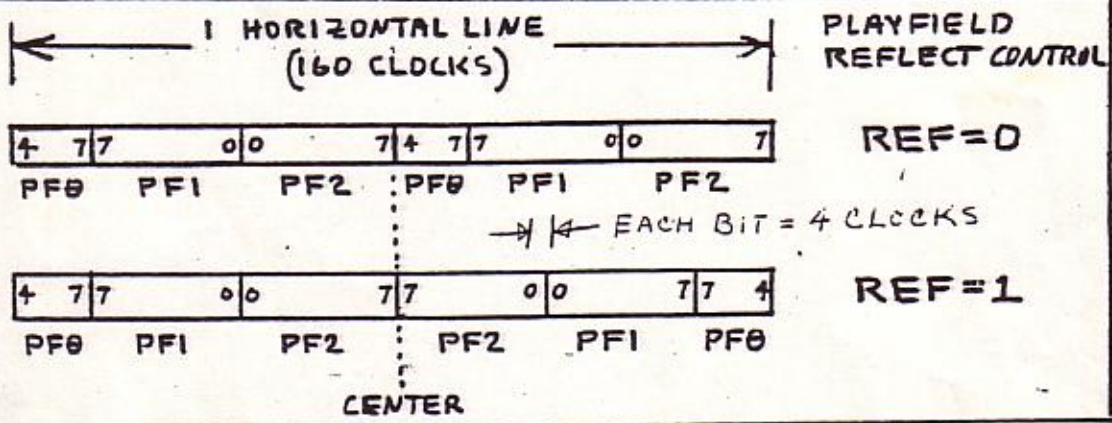
D7 { 1 DUMP I6 I1 I2 I3 PORTS TO GROUND
0 REMOVE DUMP PATH TO GROUND

PF0 (PF1, PF2)

THESE ADDRESSES ARE USED TO WRITE INTO THE PLAYFIELD REGISTERS

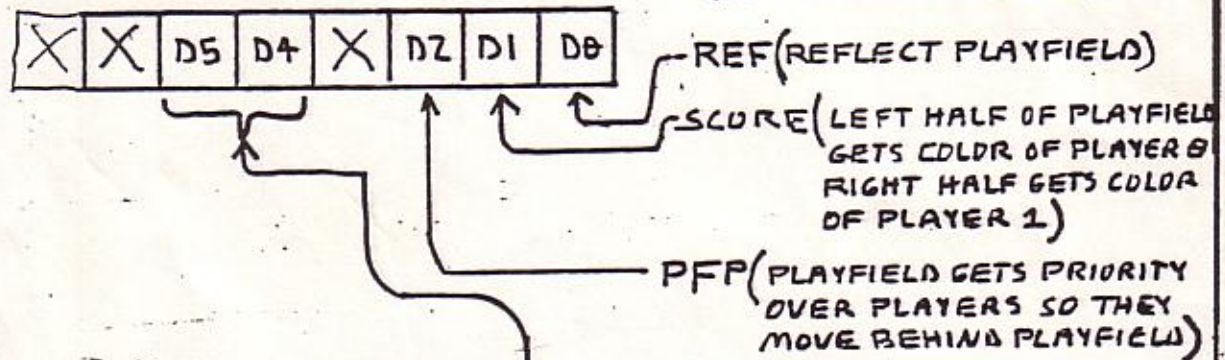


PLAYFIELD REGISTERS SERIAL OUTPUT



CTRLPF

THIS ADDRESS IS USED TO WRITE INTO THE PLAYFIELD CONTROL REGISTER (A LOGIC 1 CAUSES ACTION) AS DESCRIBED BELOW

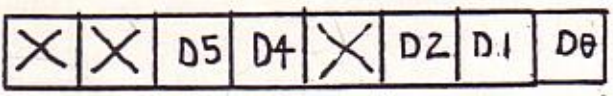


BALL SIZE		
D5	D4	WIDTH
0	0	1 CLOCK
0	1	2 CLOCKS
1	0	4 CLOCKS
1	1	8 CLOCKS

42 SHEETS 10 SHEETS 1 SQUARE
 42 SHEETS 100 SHEETS 1 SQUARE
 42 SHEETS 100 SHEETS 1 SQUARE
 NATIONAL INSTRUMENTS

NUSIZ0 (NUSIZ1)

THESE ADDRESSES CONTROL THE NUMBER AND SIZE OF PLAYERS AND MISSILES.



MISSILE SIZE		
D5	D4	WIDTH
0	0	1 CLOCK
0	1	2 CLOCKS
1	0	4 CLOCKS
1	1	8 CLOCKS

PLAYER-MISSILE NUMBER + PLAYER SIZE			DESCRIPTION
D2	D1	D0	
0	0	0	ONE COPY
0	0	1	TWO COPIES CLOSE
0	1	0	TWO COPIES MED
0	1	1	THREE COPIES CLOSE
1	0	0	TWO COPIES WIDE
1	0	1	DOUBLE SIZE PLAYER
1	1	0	3 COPIES MEDIUM
1	1	1	QUAD SIZE PLAYER

Handwritten notes: '1 TELEVISION LINE (160 CLOCKS)' with arrows spanning the table width. '8' with arrows indicating a sub-width. '4 2 1' at the bottom left of the table.

32 16 2 32

16+

42-28 10 SHEETS 1 SQUARE
 42-29 10 SHEETS 1 SQUARE
 42-30 10 SHEETS 1 SQUARE
 NATIONAL

RESPO (RESPI, RESMO, RESMI, RESBL)

THESE ADDRESSES ARE USED TO RESET PLAYERS MISSILES AND THE BALL. THE OBJECT WILL BEGIN ITS SERIAL GRAPHICS AT THAT TIME OF A HORIZONTAL LINE AT WHICH THE RESET ADDRESS OCCURS.

NO DATA BITS ARE USED

RESMP0 (RESMP1)

THESE ADDRESSES ARE USED TO RESET THE HORIZ. LOCATION OF A MISSILE TO THE CENTER OF IT'S CORRESPONDING PLAYER. AS LONG AS THIS CONTROL BIT IS TRUE (1) THE MISSILE WILL REMAIN LOCKED TO THE CENTER OF IT'S PLAYER AND THE MISSILE GRAPHICS WILL BE DISSABLED, WHEN A ZERO IS WRITTEN INTO THIS LOCATION THE MISSILE IS ENABLED, AND CAN BE MOVED INDEPENDENTLY FROM THE PLAYER.



RESMP (MISSILE-PLAYER RESET)

HMOVE

THIS ADDRESS CAUSES THE HORIZONTAL MOTION REGISTER VALUES TO BE ACTED UPON DURING THE HORIZONTAL BLANK TIME IN WHICH IT OCCURS. IT MUST OCCUR AT THE BEGINNING OF HORIZ. BLANK IN ORDER TO ALLOW TIME FOR GENERATION OF EXTRA CLOCK PULSES INTO THE HORIZONTAL POSITION COUNTERS. IF MOTION IS DESIRED THIS COMMAND MUST IMMEDIATELY FOLLOW A WSYNC COMMAND IN THE PROGRAM.

NO DATA BITS ARE USED

HMCLR

THIS ADDRESS CLEARS ALL HORIZONTAL MOTION REGISTERS TO ZERO (NO MOTION)

NO DATA BITS ARE USED

10 SHEETS 1 SQUARE
12 SHEETS 1 SQUARE
14 SHEETS 1 SQUARE
16 SHEETS 1 SQUARE
18 SHEETS 1 SQUARE
20 SHEETS 1 SQUARE
22 SHEETS 1 SQUARE
24 SHEETS 1 SQUARE
26 SHEETS 1 SQUARE
28 SHEETS 1 SQUARE
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78 SHEETS 1 SQUARE
80 SHEETS 1 SQUARE
82 SHEETS 1 SQUARE
84 SHEETS 1 SQUARE
86 SHEETS 1 SQUARE
88 SHEETS 1 SQUARE
90 SHEETS 1 SQUARE
92 SHEETS 1 SQUARE
94 SHEETS 1 SQUARE
96 SHEETS 1 SQUARE
98 SHEETS 1 SQUARE
100 SHEETS 1 SQUARE
NATIONAL INSTRUMENTS

HMPθ (HMP1, HMMθ, HMM1, HMBL)

THESE ADDRESSES WRITE DATA (HORIZONTAL MOTION VALUES) INTO THE HORIZONTAL MOTION REGISTERS. THESE REGISTERS WILL CAUSE HORIZONTAL MOTION ONLY WHEN COMMANDED TO DO SO BY THE HORIZ. MOVE COMMAND HMOVE.

THE MOTION VALUES ARE CODED AS SHOWN BELOW.

D7	D6	D5	D4	
0	1	1	1	+7
0	1	1	0	+6
0	1	0	1	+5
0	1	0	0	+4
0	0	1	1	+3
0	0	1	0	+2
0	0	0	1	+1
0	0	0	0	0
1	1	1	1	-1
1	1	1	0	-2
1	1	0	1	-3
1	1	0	0	-4
1	0	1	1	-5
1	0	1	0	-6
1	0	0	1	-7
1	0	0	0	-8

MOVE LEFT INDICATED NUMBER OF CLOCKS

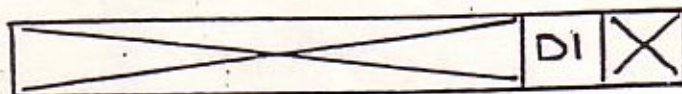
NO MOTION

MOVE RIGHT INDICATED NUMBER OF CLOCKS

WARNING: These motion registers should not be modified during the 24 Computer cycles immediately following an H Move command. Unpredictable motion values may result.

ENAMθ (ENAM1, ENABL)

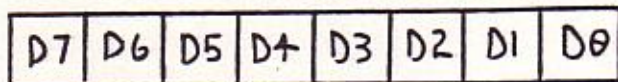
THESE ADDRESSES WRITE D1 INTO THE 1 BIT MISSILE OR BALL GRAPHICS REGISTERS.



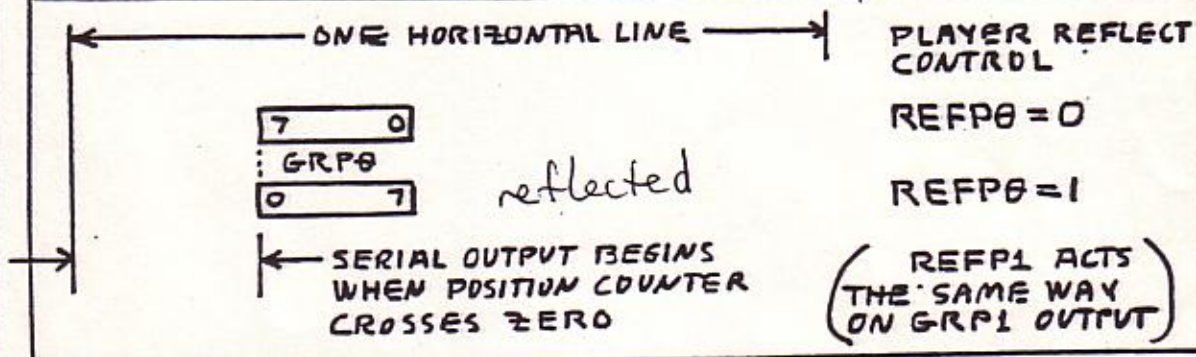
0 DISSABLES OBJECT
1 ENABLES OBJECT

GRP0 (GRP1)

THESE ADDRESSES WRITE DATA INTO THE PLAYER GRAPHICS REGISTERS

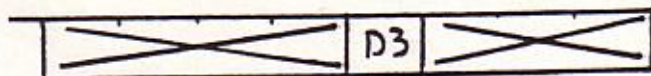


PLAYER GRAPHICS REGISTER SERIAL OUTPUT



REFP0 (REFP1)

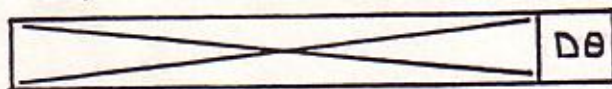
THESE ADDRESSES WRITE D3 INTO THE 1 BIT PLAYER REFLECT REGISTERS.



- 0 NO REFLECT (D7 OF GRP ON LEFT)
- 1 REFLECT (D0 OF GRP ON LEFT)

VDELP0 (VDELP1, VDELBL)

THESE ADDRESSES WRITE D0 INTO THE 1 BIT VERTICAL DELAY REGISTERS, TO DELAY PLAYERS OR BALL BY ONE VERTICAL LINE.



- 0 NO DELAY
- 1 DELAY

CXCLR

THIS ADDRESS CLEARS ALL COLLISION LATCHES TO ZERO (NO COLLISION)

DATA BITS NOT USED

30 SHEETS 3 SQUARE
31 SHEETS 3 SQUARE
32 SHEETS 3 SQUARE
NATIONAL

COLUPB(COLUP1, COLUPF, COLUBK)

THESE ADDRESSES WRITE DATA INTO THE
PLAYER, PLAYFIELD, AND BACKGROUND COLOR-
LUMINANCE REGISTERS.

<u>COLOR</u>	<u>COLOR</u>					<u>LUM</u>			<u>LUM</u>
	D7	D6	D5	D4	D3	D2	D1	X	
GREY-GOLD	0	0	0	0	0	0	0	0	BLACK
	0	0	0	1	0	0	1	1	DARK GREY
ORANGE, RED-ORG	0	0	1	0	0	1	0	1	⋮
	0	0	1	1	0	1	1	1	GREY
PINK-PURPLE	0	1	0	0	1	0	0	0	⋮
	0	1	0	1	1	0	1	1	⋮
PURP-BLUE, BLUE	0	1	1	0	1	1	0	0	LIGHT GREY
	0	1	1	1	1	1	1	1	WHITE
BLUE-LT. BLUE	1	0	0	0					
	1	0	0	1					
TORQ.-GAN. BLUE	1	0	1	0					
	1	0	1	1					
GAN.-YEL. GAN.	1	1	0	0					
	1	1	0	1					
ORG.GAN-LT.ORG.	1	1	1	0					
	1	1	1	1					

AUDF0(AUDF1)

THESE ADDRESSES WRITE DATA INTO THE
AUDIO FREQUENCY DIVIDER REGISTERS.

X	D4	D3	D2	D1	D0	<u>30KHZ DIVIDED BY</u>
	0	0	0	0	0	DIVIDE BY 1 (NO DIVISION)
	0	0	0	0	1	DIVIDE BY 2
	0	0	0	1	0	DIVIDE BY 3
						⋮
	1	1	1	1	0	DIVIDE BY 31
	1	1	1	1	1	DIVIDE BY 32

AUDC0(AUDC1)

THESE ADDRESSES WRITE DATA INTO THE AUDIO CONTROL REGISTERS WHICH CONTROL THE NOISE CONTENT AND ADDITIONAL DIVISION OF THE AUDIO OUTPUT.

XXXXXXXX	D3	D2	D1	D0
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HEX CODE

0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
A	1	0	1	0
B	1	0	1	1
C	1	1	0	0
D	1	1	0	1
E	1	1	1	0
F	1	1	1	1

TYPE OF NOISE OR DIVISION

SET TO 1
 4 BIT POLY *Electronic*
 ÷15 → 4 BIT POLY
 5 BIT POLY → 4 BIT POLY
 ÷2 } pure tone
 ÷2 }
 ÷31 }
 5 BIT POLY → ÷2
 9 BIT POLY (WHITE NOISE)
 5 BIT POLY
 ÷31 } pure tone
 SET LAST 4 BITS TO 1
 ÷6 } pure tone
 ÷6 }
 ÷93 }
 5 BIT POLY ÷6

AUDV0(AUDV1)

THESE ADDRESSES WRITE DATA INTO THE AUDIO VOLUME REGISTERS WHICH SET THE PULL DOWN IMPEDANCE DRIVING THE AUDIO OUTPUT PADS.

XXXXXXXX	D3	D2	D1	D0
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0	0	0	0
0	0	0	1
0	0	1	0
-	-	-	-
1	1	1	0
1	1	1	1

AUDIO OUTPUT PULLDOWN CURRENT

NO OUTPUT CURRENT
 LOWEST

HIGHEST

WRITE ADDRESS SUMMARY PG 1 OF 2

REV.
NOV 2,
1976

4 BIT ADDRESS		ADDRESS NAME	DATA BITS USED				FUNCTION				
OCT	HEX		7	6	5	4		3	2	1	0
00	00	VSYNC								1	VERTICAL SYNC SET-CLEAR
01	01	VBLANK	1	1						1	VERTICAL BLANK SET-CLEAR
02	02	WSYNC									WAIT FOR LEADING EDGE OF HORIZONTAL BLANK
03	03	RSYNC									RESET HORIZONTAL SYNC COUNTER
04	04	NUSIZ θ			1	1				1	NUMBER-SIZE PLAYER-MISSILE θ
05	05	NUSIZ1			1	1				1	NUMBER-SIZE PLAYER-MISSILE 1
06	06	COLUP θ	1	1	1	1				1	COLOR-LUM PLAYER θ
07	07	COLUP1	1	1	1	1				1	COLOR-LUM PLAYER 1
10	08	COLUPF	1	1	1	1				1	COLOR-LUM PLAYFIELD
11	09	COLUBK	1	1	1	1				1	COLOR-LUM BACKGROUND
12	0A	CTRLPF			1	1				1	CONTROL PLAYFIELD BALL SIZE AND COLLISIONS
13	0B	REFP θ								1	REFLECT PLAYER θ
14	0C	REFP1								1	REFLECT PLAYER 1
15	0D	PF θ	1	1	1	1					PLAYFIELD REG. BYTE θ
16	0E	PF1	1	1	1	1	1	1	1	1	PLAYFIELD REG. BYTE 1
17	0F	PF2	1	1	1	1	1	1	1	1	PLAYFIELD REG. BYTE 2
20	10	RESP θ									RESET PLAYER θ
21	11	RESP1									RESET PLAYER 1
22	12	RESM θ									RESET MISSILE θ
23	13	RESM1									RESET MISSILE 1
24	14	RESBL									RESET BALL
25	15	AVDC θ								1	AUDIO CONTROL θ
26	16	AVDC1								1	AUDIO CONTROL 1

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WRITE ADDRESS SUMMARY

6 BIT ADDRESS		ADDRESS NAME	DATA BITS USED						FUNCTION	
			7	6	5	4	3	2		1
OCT	HEX									
27	17	AUDF0		1	1	1	1	1		AUDIO FREQUENCY 0
30	18	AUDF1		1	1	1	1	1		AUDIO FREQUENCY 1
31	19	AUDV0			1	1	1	1		AUDIO VOLUME 0
32	1A	AUDV1			1	1	1	1		AUDIO VOLUME 1
33	1B	GRP0	1	1	1	1	1	1	1	GRAPHICS PLAYER 0
34	1C	GRP1	1	1	1	1	1	1	1	GRAPHICS PLAYER 1
35	1D	ENAM0							1	GRAPHICS (ENABLE) MISSILE 0
36	1E	ENAM1							1	GRAPHICS (ENABLE) MISSILE 1
37	1F	ENABL							1	GRAPHICS (ENABLE) BALL
40	20	HMP0	1	1	1	1				HORIZONTAL MOTION PLAYER 0
41	21	HMP1	1	1	1	1				HORIZONTAL MOTION PLAYER 1
42	22	HMM0	1	1	1	1				HORIZONTAL MOTION MISSILE 0
43	23	HMM1	1	1	1	1				HORIZONTAL MOTION MISSILE 1
44	24	HM BL	1	1	1	1				HORIZONTAL MOTION BALL
45	25	VDELP0							1	VERTICAL DELAY PLAYER 0
46	26	VDELP1							1	VERTICAL DELAY PLAYER 1
47	27	VDEL BL							1	VERTICAL DELAY BALL
50	28	RESMP0							1	RESET MISSILE 0 TO PLAYER 0
51	29	RESMP1							1	RESET MISSILE 1 TO PLAYER 1
52	2A	HMOVE								STROBE APPLY HORIZONTAL MOTION
53	2B	HMCLR								STROBE CLEAR HORIZ. MOTION REGS.
54	2C	CXCLR								STROBE CLEAR COLLISION LATCHES

THE UNIVERSITY MICROFILMS INTERNATIONAL
 300 NORTH ZEEB ROAD
 ANN ARBOR, MICHIGAN 48106

READ ADDRESS SUMMARY PG 1 OF 1

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REV
NOV
2
1976

4 BIT ADDRESS		ADDRESS NAME	DATA BITS USED							FUNCTION			
			7	6	5	4	3	2	1			0	D7
00	00	CXM0P	1	1							READ COLLISION	M0·PI	M0·P0
01	01	CXM1P	1	1							"	M1·P0	M1·PI
02	02	CXP0FB	1	1							"	P0·PF	P0·BL
03	03	CXP1FB	1	1							"	PI·PF	PI·BL
04	04	CXM0FB	1	1								M0·PF	M0·BL
05	05	CXM1FB	1	1								M1·PF	M1·BL
06	06	CXBLPF	1									BL·PF	NOT USED
07	07	CXPPMM	1	1								P0·PI	M0·MI
10	08	INPT0	1								READ POT PORT	I0	X
11	09	INPT1	1								READ POT PORT	I1	X
12	0A	INPT2	1								READ POT PORT	I2	X
13	0B	INPT3	1								READ POT PORT	I3	X
14	0C	INPT4	1								READ INPUT	I4	X
15	0D	INPT5	1								READ INPUT	I5	X
											NOTE; I0, I1, I2, I3, CAN be grounded under SOFTWARE CONTROL.		
											I4, I5 CAN be converted to LATCHED INPUTS under SOFTWARE CONTROL.		

42-100 50 SHEETS 5 SQUARE
 42-100 100 SHEETS 3 SQUARE
 42-100 200 SHEETS 3 SQUARE
 NATIONAL
 ELECTRONIC CORPORATION