



## **C.P.U. EXORCISER**

# PRELIMINARY USER MANUAL

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## The Cinematronics C.P.U. Exorciser

The Cinematronics Exorciser was designed to help Test Technicians diagnose circuit faults in the main logic board, a.k.a. CPU, used in all the early Cinematronics Vector based arcade games. The Exorciser connects to the board under test and injects digital signals into a number of circuit nodes forcing the board to operate in a stable and repeatable manner. With the board in this state the technician can diagnose many component failures by simply reading the digital signatures present on the board and comparing them to the correct signatures which are shown on the schematics. Debugging becomes a simple matter of finding the device which is causing the incorrect signature and replacing it.

### Signature Analysis

From the HP Test & Measurement catalog, here's a description of Signature Analysis:

*Signature analysis is a fast and accurate method of troubleshooting digital circuits. Finding faults is reduced to tracing signal flow and comparing measured signatures to printouts or computer-stored signatures. A signature is a 16 bit-cyclic redundancy code (CRC) generated for blocks of data. Instead of entire bit streams, only signatures are compared to detect errors.*

*HP's patented signature analysis technique enables the HP5005B or HP5006A to generate a compressed, four-digit 'fingerprint' or signature of a digital data stream at a logic node. Any fault associated with a device connected to the node will force a change in the data stream and produce an erroneous signature.*

In other words, a signature is a four digit Hexadecimal representation a binary pattern measured within a 'window' defined by a START and a STOP signal. The signatures that are used as a reference were measured on a 'known-good' PC board similar to the board under test (DUT). The reference board and the DUT must be driven by identical signal patterns, or exercised, to obtain the proper results. This is just what the Exorciser does.

### Equipment Necessary

- Signature Analyzer (HP5004A, HP5006A, Atari Cat Box, etc.)
- +5 Volt DC @ 5A Power Supply or Cinematronics Power Supply
- 100 MHz or higher Oscilloscope w/probes
- 2 \_ - Digit or better Digital Multi-meter (DMM) w/leads
- 16 pin DIP Clip
- Ball Clip or E-Z Hook clip leads, various lengths
- Cinematronic CPU Schematics w/signatures

## HP5004A Self-Test

This section covers the Self-Test feature of the HP5004A. If you are using a different type of Signature Analyzer you must refer to its user manual for the Self-test operation.

1. Remove the grabber connectors from the pod test leads, and connect the pod (START, STOP and CLOCK) leads to the matching START, STOP and CLOCK receptacles on the 5004A front panel.
2. Connect the 5004A data probe to the probe test receptacle on the 5004A front panel. Push the probe tip point gently and firmly into the PROBE TEST receptacle until the point is held securely.
3. Connect the 5004A power cable to the correct power source and set the 5004A front panel as follows:

### Test A

#### Switch Settings:

START:	IN
STOP:	IN
CLOCK:	IN or OUT

#### Displays:

Four seven-segment:	UP73 then ACA2
Gate:	flickers
Unstable Signature:	flickers except when good signature is on
Probe tip light:	Flickers when "ACA2" is on

### Test B

#### Switch Settings:

START:	OUT
STOP:	OUT
CLOCK:	IN or OUT

#### Displays:

Four seven-segment:	3951 then 2P61
Gate:	flickers
Unstable Signature:	flickers except when good signature is on
Probe tip light:	Flickers when "2P61" is on

### Note

In SELF-TEST mode, the seven-segment displays first have all seven segments lit dimly for about 1 second (tests all segments) and then have one of the signature sets listed above for about 1 second. If the probe RESET switch is pressed during the SELF-TEST mode, the four 7-segment-digit displays will show all zeros except when all segments are dimly lit.

1. Connect the 5004A's grabber connectors as follows:

CLK (yellow) clip to Exorciser CLK terminal,  
START (green) clip to Exorciser START/STOP terminal,  
STOP (red) clip to Exorciser START/STOP terminal,  
GND (black) clip to Exorciser GND terminal.

2. Connect The Exorciser's +5V banana jack to the 5 volt source, either from the Cinematronics power supply or a lab supply. In the same manner connect the GND banana jack to the supply's GROUND connection. Verify that the board under test is connected to the +5 volt supply also.

3. Using a short jumper lead connect the Exorciser's CLK terminal to the CLK test point on the logic board. This point is located between IC's Jx and Kx and is marked CLK on the component side of the board.

At this point the Exorciser has all the necessary inputs connected to perform an operational verification test. If this test is not necessary skip the next section.

## Verifying the Exorciser output signatures

With the equipment connected as described in the previous section apply power to the +5V power supply. Verify that the supply is still putting out +5.0 volts DC  $\pm$  0.25VDC.

Set the switches on the signature analyzer as follows:

### HP5004A Switch Settings:

START:	IN (negative edge)
STOP:	OUT (positive edge)
CLOCK:	OUT (positive edge)

With the analyzer's data probe verify the following signatures at the specified locations:

<b>DIP plug D8</b>	<u>pin</u>	<u>signature</u>
	#4	7825
	#5	655C
	#9	802H
	#10	6PF3
	#11	8UC2
	#14	2518
	#15	0000
	#16	U6HH

## Verifying the Exorciser output signatures (cnt'd)

<b>DIP plug U14</b>	<u>pin</u>	<u>signature</u>
	#9	5555
	#10	CCCC
	#11	7F7F

#12	5H21
#13	0AFA
#14	UPFH
#15	52F8
#16	HC89

<b>DIP clip N2</b>	<u>pin</u>	<u>signature</u>
	#4	F469
	#7	PH6F
	#9	211U
	#12	H28U

<b>DIP clip R2</b>	<u>pin</u>	<u>signature</u>
	#4	A69C
	#7	47F6
	#9	8CC5
	#12	510F

<b>Dip clip T2</b>	<u>pin</u>	<u>signature</u>
	#4	615F
	#7	A928
	#9	A29F
	#12	96FC

## Preliminary CPU Operational Testing

There is a certain minimum operation level which the CPU board must meet before the Exorciser can be used for fault diagnostics. The 20MHz oscillator circuit (IC-I2, XTAL, R2, R3 and C59) must be operating. The IC's H2 (74S113) and J4 (74265) must also be operational and generating the four clock signals CLK1, /CLK1, CLK2 and /CLK2. Refer to Sheet 1 of the schematics and, with the oscilloscope, verify that these clock signals are present. Note that the CLK1 signal's amplitude will be attenuated when the Exorciser is connected, this is normal. The signal '**POWER\_UP**' at IC B6 pin 2 (74LS04) must be at a TTL High ( $V_o\_2V$ ). If these requirements are not met the Exorciser will not operate. These circuits must be repaired before the Exorciser can be used.

## Connecting the Exorciser to the Board Under Test

**IMPORTANT!**  
**Before you connect the Exorciser verify that  
the 5 volt power supply is turned OFF!**

Connecting the Exorciser to the CPU is a simple task. First disconnect the ribbon cable which connects to the display. Then remove the two 16-pin DIP shunts located at D8 and U14. Connect the DIP plug at the end of the cable which plugs into J3 of the Exorciser into the IC socket at D8. Connect the other DIP plug at the end of the cable which plugs into J1 into the socket at U14. Attach the DIP

clip designated N2 to the IC-N2 (74LS257) paying close attention to the location of pin 1. Attach the R2 DIP clip to IC-R2 and the T2 DIP clip to IC-T2. There is a flying ball-clip connected to the cable from J1, this clip is attached to the test point TP8. No IC's need to be removed from the board in order to use the Exorciser.

## Reading Signatures and Verification

With the equipment hooked up as described in the previous sections turn on the power to the analyzer and the DC power supply. Set the Signature Analyzer to the configuration shown below. Debugging is now a simple matter of touching the probe tip to a specific IC pin and comparing it's signature to that shown on the schematic. The expected signatures are listed in Appendix A for reference. The key below defines the terms used in the tables.

### HP5004A Switch Settings:

START:	IN (negative edge)
STOP:	OUT (positive edge)
CLOCK:	OUT (positive edge)

**NOTE:** Some circuit nodes have two signatures shown, the upper (first) value is read when the CLOCK is positive edge triggered and the lower (second) value when the CLOCK is negative edge triggered.

## Detecting faulty devices

In most cases detecting a defective device is as simple as finding a bad signature and finding the IC which is driving the node. Once you find a bad signature follow the signal 'up-stream' to the first IC at which a bad signature shows up at. If all the input signatures to this IC are correct and the output is not there a good chance you've found a bad device. This reasoning may not lead to a correct determination if, for instance, there is a short affecting the bad node or if an IC connected to the node has a shorted input. It's always a good idea to check the node in question with a meter and an oscilloscope to help further diagnose a problem.

## Testing the board for Non-JMI mode

Some of the signatures listed in Appendix A are shown within two forward slashes (/nnnn/). These are signatures read when the board has been put in the non-JMI mode. The JMI jumper must be removed, if present, to obtain these signatures. Be sure to replace this jumper when testing has been completed.

## Testing the board's RAM Addressing Signatures

There are eight unique signatures in Appendix A shown with an asterisk (\*) prefix. These are the signatures for the eight RAM address lines, A0 thru A7. To obtain these signatures pin 10 of IC I12 and pin 10 of IC J12 must be tied to ground. These pins are connected together by a trace so it's only necessary to ground one. This can be done simply by using a 16-pin DIP clip with pins 10 and 8 tied together and placing the clip on either IC I12 or J12.

## Tips & Techniques

The IC's on the Cinematronics CPU board have reference designations that correspond to their X and Y position on the board. The grid lines are designated U thru A across the wide dimension (horizontal if the board is positioned with the connectors along the top) and 2 thru 14 across the shorter (vertical) width. Unfortunately, there are no reference designations shown on the board for each IC. To speed up the debug process I *highly* recommend placing a small label on various IC's and marking them with it's reference designation and the number of pins the IC has. The small (5/8" x 3/16") IC labels that are available in 8 \_" X 11" sheets with 480 labels each are ideal.

Always check the test point marked C3-2P first. This is the RESET node and it's signature should be 'C32P'. If the signature is incorrect repair the reset circuit before continuing.

Always trace bad signatures in the opposite direction of the signal flow. A good starting point is at the X and Y data output latches and the line intensity control circuit.

A bad signature at an input of an IC will not *always* cause a bad signature at it's output.

An inverted signal will always have the same signature as it's non-inverted source signal.



Schematic: SHT1

Schematic: SHT2

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
B4	13	74LS00	A328	T2	1	74LS257	49P2
B4	11		A328	T2	2		HAFA
B4	1		Lo	T2	5		UAC5
B4	6		Hi	T2	11		651H
E4	7	74LS151	49P2	T2	14		F567
E4	11		PH07	T2	3		F6A4
E4	10		29A9	T2	6		HA32
E4	9		80HP	T2	10		F97P
E4	5		49P2	T2	13		0C22
F4	9	74LS10	49P2	T2	15		Hi
F4	10		392C	T2	4		615F
F4	11		392C	T2	7		A928
F4	8		A522	T2	9		A29F
D4	5	74LS151	A522	T2	12		96FC
B6	11	74LS04	392C	R2	1	74LS257	49P2
B6	10		392C	R2	2		9172
C4	5	74LS151	392C	R2	5		711H
F6	9	74LS27	49P2	R2	11		FPF2
F6	10		A522	R2	14		HAC9
F6	11		392C	R2	3		P38A
F6	8		Lo	R2	6		30CC
A6	8	74LS02	Lo	R2	10		FUC5
A6	9		9069	R2	13		725C
A6	10		9069	R2	15		Hi
B6	13	74LS04	H28U	R2	4		A69C
B6	12		H28U	R2	7		47F6
F2	1	74LS259	PH07	R2	9		8CC5
F2	2		29A9	R2	12		510F
F2	3		80HP	N2	1	74LS257	49P2
F2	13		H28U	N2	2		26PP

F2	14		0000		N2	5		67HU
F2	4		FH1H		N2	11		166U
F2	5		54P5		N2	14		C432
F2	6		8CAU		N2	3		OU1F
F2	7		2043		N2	6		0841
F2	9		A941		N2	10		242C
F2	10		A328		N2	13		AC5H
F2	11		C9UC		N2	15		Hi
F2	12		82CU		N2	4		F469

Schematic: SHT2

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
N2	7	74LS257	PH6F	N4	9	74LS194	C5F6
N2	9		211U	N4	7		HAC9
N2	12		H28U	N4	2		Lo
				N4	12		26PP
K2	12	74LS32	7P23	N4	13		67HU
K2	13		49P2	N4	14		166U
K2	11		7P23	N4	15		C432
L2	9	74LS10	clk1	J6	1	74LS00	7P23
L2	10		F1CH	J6	2		C432
L2	11		7P23	J6	3		0A76
T4	3	74LS194	1C14	J6	4		F6A4
T4	4		8236	J6	5		41UC
T4	5		304P	J6	6		FC5H
T4	6		FC6A	J6	9		FC5H
T4	10		2H8F	J6	10		0A76
T4	9		C5F6	J6	8		F12C
T4	7		HAFA	L2	3	74LS10	49P2
T4	2		9172	L2	4		F1CH
T4	12		HAFA	L2	5		clk2
T4	13		UAC5	S4	3	74LS194	1C14
T4	14		651H	S4	4		8236
T4	15		F567	S4	5		304P
R4	3	74LS194	F43F	S4	6		FC6A
R4	4		5000	S4	10		2H8F
R4	5		34CP	S4	9		C5F6
R4	6		66UU	S4	7		F12C
R4	10		2H8F	S4	2		P38A
R4	9		C5F6	S4	12		F6A4
R4	7		F567	S4	13		HA32
R4	2		26PP	S4	14		F97P

R4	12		9172		S4	15		0C22
R4	13		711H		P4	3	74LS194	F43F
R4	14		FPF2		P4	4		5000
R4	15		HAC9		P4	5		34CP
N4	3	74LS194	9115		P4	6		66UU
N4	4		61CA		P4	10		2H8F
N4	5		91CC		P4	9		C5F6
N4	6		6121		P4	7		0C22
N4	10		2H8F					

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
P4	2	74LS194	0U1F	I12	7	74LS298	PH07
P4	12		P38A	I12	10		AAP8
P4	13		30CC	I12	11		0000
P4	14		FUC5	I12	12		_F6C6
P4	15		725C	I12	13		_402U
M4	3	74LS194	9115	I12	14		_01F4
M4	4		61CA	I12	15		_PPC3
M4	5		91CC	E12	1	74LS04	4A50
M4	6		6121	E12	2&3		4A50
M4	10		2H8F	E12	4		4A50
M4	9		C5F6	N14	20	9101C	4A50
M4	7		725C	N14	9		96FC
M4	12		0U1F	N14	11		A29F
M4	13		0841	N14	13		A928
M4	14		242C	N14	15		615F
M4	15		AC5H	N14	1		_0038
				N14	2		_6034
H12	3	74LS194	392C	N14	3		_UCCC
H12	4		80HP	N14	4		_PF3C
H12	5		29A9	N14	5		_PPC3
H12	6		PH07	N14	6		_01F4
H12	9&10		CH9A	N14	7		_402U
H12	12		0PH1	N14	21		_F6C6
H12	13		54CC	M14	20	9101C	4A50
H12	14		H255	M14	9		510F
H12	15		7H33	M14	11		8CC5
J12	3	74LS298	7H33	M14	13		47F6
J12	4		H255	M14	15		A69C
J12	5		54CC	M14	1		_0038
J12	7		0PH1	M14	2		_6034

J12	10		AAP8		M14	3		_UCCC
J12	11		0000		M14	4		_PF3C
J12	12		_PF3C		M14	5		_PPC3
J12	13		_UCCC		M14	6		_01F4
J12	14		_6034		M14	7		_402U
J12	15		_0038		M14	21		_F6C6
I12	3	74LS298	392C		L14	20	9101C	4A50
I12	4		80HP		L14	9		H28U
I12	5		29A9		L14	11		211U

Schematic: SHT3

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
L14	13	9101C	PH6F	H10	6	74LS32	P6AF
L14	15		F469	N9	1	74LS85	8C81
L14	1		_0038	N9	2		9398
L14	2		_6034	N9	3		9686
L14	3		_UCCC	N9	4		051P
L14	4		_PF3C	N9	9		1776
L14	5		_PPC3	N9	10		H9P9
L14	6		_01F4	N9	11		9AC5
L14	7		_402U	N9	12		A29F
L14	21		_F6C6	N9	13		A928
N11	3	74LS157	392C	N9	14		C428
N11	6		80HP	N9	15		615F
N11	10		29A9	N9	5		A197
N11	13		PH07	N9	6		237P
N11	15		4UHF	M9	1	74LS85	67C8
N11	4		8C81	M9	2		0PF5
N11	7		C428	M9	3		Lo
N11	9		9AC5	M9	4		510F
N11	12		67C8	M9	9		A8H3
M11	3	74LS157	37C1	M9	10		8CC5
M11	6		HP4P	M9	11		6C47
M11	10		P75P	M9	12		47F6
M11	13		A6HF	M9	13		A69C
M11	15		3P10	M9	14		C781
M11	4		C781	M9	15		96FC
M11	7		6C47	M9	5		H9P9
M11	9		A8H3	L9	1	74LS85	P9UF
M11	12		0PF5	L9	9		96AF
L11	3	74LS157	392C	L9	10		H28U
L11	6		80HP	L9	11		6HF3

L11	10		29A9		L9	12		211U
L11	13		PH07		L9	13		PH6F
L11	15		7323		L9	14		A996
L11	4		P9UF		L9	15		F469
L11	7		A996		L9	5		051P
L11	9		6HF3		L9	6		9686
L11	12		76F5		N6	1	25LS181	67C8
H10	4	74LS32	9069		N6	2		96FC
H10	5		76F5		N6	3		60P1



Schematic: SHT3

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
N6	4	25LS181	60P1	L6	3	25LS181	60P1
N6	5		211A	L6	4		60P1
N6	6		HC91	L6	5		211A
N6	7		H3UF	L6	6		HC91
N6	8		41UC	L6	7		9A6A
N6	18		8C81	L6	8		41UC
N6	19		615F	L6	18		P9UF
N6	20		C428	L6	19		F469
N6	21		A928	L6	20		A996
N6	22		9AC5	L6	21		PH6F
N6	23		A29F	L6	22		6HF3
N6	9		1C14	L6	23		211U
N6	10		8236	L6	9		9115
N6	11		304P	L6	10		61CA
N6	13		FC6A	L6	11		91CC
N6	15		7A6F	L6	13		6121
N6	17		3H1C	L6	15		235P
M6	1	25LS181	0PF5	L6	17		21H0
M6	2		510F	U2	9	74S04	9A6A
M6	3		60P1	U2	8		9A6A
M6	4		60P1	K2	4	74LS32	41UC
M6	5		211A	K2	5		9A6A
M6	6		HC91	K2	6		60P1
M6	7		2632	K2	9		9A6A
M6	8		41UC	K2	10		41UC
M6	18		C781	K2	8		211A
M6	19		A69C	K4	2	74LS02	41UC
M6	20		6C47	K4	3		9A6A
M6	21		47F6	K4	1		60P1
M6	22		A8H3	J8	1	74LS86	41UC

M6	23		8CC5		J8	2		9A6A
M6	9		F43F		J8	3		HC91
M6	10		5000					
M6	11		34CP		U9	4 & 13	74LS75	0000/H33 C
M6	13		66UU		U9	4 & 13		[5A4H]
M6	15		6023		T9	4 & 13	74LS75	0000/H33 C
M6	17		70AF		T9	4 & 13		[5A4H]
L6	1	25LS181	P6AF					
L6	2		H28U					

## SHT4

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
U11	1	74LS157	90AP	J14	3	74S288	P503
U11	15		C32P	J14	4		C15P
T11	1	74LS157	90AP	J14	5		90AP
T11	15		C32P	H14	2	74S02	P503
T13	1	74LS377	802H	H14	3		U646
T13	3		HC89	H14	1		FU1U
T13	4		UPFH	I14	1	74LS163	C32P
T13	7		5H21	I14	3		H666
T13	8		CCCC	I14	6		FU3U
T13	13		5555	I14	9		FU1U
T13	14		7F7F	I14	7 & 10		891F
T13	17		0AFA	I14	11		6069
T13	18		52F8	I14	12		891F
T13	2		6H37	I8	9	74LS04	891F
T13	5		1F1A	I8	8		891F
T13	6		4C4H	I10	13	74S00	19AP
T13	9		4819	I10	12		6069
T13	12		5547	I10	11		6909
T13	15		1106	H14	11	74S02	5278
T13	16		8884	H14	12		6909
T13	19		C004	H14	13		H33C
S13	1	74LS377	6PF3	H14	9		H33C
S13	2		PH07	H14	8		891F
S13	5		29A9	H14	10		07U2
S13	6		80HP	H14	5		H33C
S13	9		392C	H14	4		0000 / H33C
S13	12		A6HF	I8	3	74LS04	2518
S13	15		P75P	I8	4		2518
S13	16		HP4P				
S13	19		37C1	J4	1	74265	578F

				J4	2		578F
				J10	1	74LS107	54CC
J14	10	74S288	655C	J10	4		0PH1
J14	11		7825	J10	12		FFC9
J14	12		6PF3	J10	13		C32P
J14	13		390P	J10	3		473U
J14	14		19AP	J10	2		473U
J14	1		H666				
J14	2		FU3U				

### Appendix A (cnt'd)

Schematic: SHT4

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
P13	3	74LS194	P6AF	R11	5		UHUH
P13	4		6HF3	R11	6		U095
P13	5		A996	R11	11		9HPH
P13	6		P9UF	R11	12		50HC
P13	9 & 10		FP22	R11	13		F0A5
P13	12		480P	R11	14		45H9
P13	13		70F4	P11	3	74LS163	2788
P13	14		98A7	P11	4		1533
P13	15		H9FP	P11	5		42P0
R13	3	74LS377	0PF5	P11	6		9U76
R13	4		A8H3	P11	11		63P6
R13	7		6C47	P11	12		CC8C
R13	8		C781	P11	13		C8PU
R13	13		67C8	P11	14		6865
R13	14		9AC5	S9	1	74LS157	19AP
R13	17		C428	S9	2		H28U
R13	18		8C81	S9	5		211U
R13	2		9UCC	S9	11		PH6F
R13	5		P6A0	S9	14		F469
R13	6		UHUH	S9	4		155C

R13	9		U095		S9	7		7211
R13	12		2788		S9	9		8066
R13	15		1533		S9	12		HA00
R13	16		42P0		R9	2	74LS157	510F
R13	19		9U76		R9	5		8CC5
S11	3	74LS163	H9FP		R9	11		47F6
S11	4		98A7		R9	14		A69C
S11	5		70F4		R9	4		UPAP
S11	6		480P		R9	7		A7U5
S11	1		C32P		R9	9		5PF5
S11	2		clk1		R9	12		FC92
S11	9		390P		P9	2	74LS157	96FC
S11	7		C15P		P9	5		A2F9
S11	11		99F8		P9	11		A928
S11	12		2CAP		P9	14		615F
S11	13		38P3		P9	4		C443
S11	14		5278		P9	7		U62F
R11	3	74LS163	9UCC		P9	9		0499
R11	4		P6A0		P9	12		578F

Schematic: SHT5

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
G12	3	74S10	C004	E14	7	74S288	409C
G12	4		8884	E14	9		07PU
G12	5		1106	D14	1	74S288	2H8F
G12	6		U24U	D14	2		A76P
G14	2	74S158	6H37	D14	3		41UC
G14	5		1F1A	D14	4		7P23
G14	11		4C4H	D14	5		9A6A
G14	14		4819	D14	6		5H61
G14	3		5547	D14	7		8ACC
G14	6		1106	D14	9		5AA5
G14	10		8884	C14	1	74S288	9069
G14	13		C004	C14	2		7323
G14	4		2293	C14	3		CH9A
G14	7		62C7	C14	4		96UA
G14	9		P68U	C14	5		67AH
G14	12		283P	C14	6		2PFF
F14	1	74S287	9673	C14	7		32U4
F14	2		51C4	C14	9		U100
F14	3		U24U	E10	9	74LS163	802H
F14	4		283P	E10	7		8UC2
F14	5		2293	E10	13		9673
F14	6		62C7	E10	14		51C4
F14	7		P68U	D10	1	74LS04	7341
F14	15		2518				
F14	9		1846	B6	9		615F
F14	10		FP05	B6	8		615F [0000]
F14	11		8399	A8	8	74LS107	615F [0000]
F14	12		61C3	A8	11		615F [0000]

E14	10	74S288	2293		A8	5		30AP [Hi]
E14	11		62C7		G10	3	74LS194	A197
E14	12		P68U		G10	4		2379
E14	13		283P		G10	5		AH4H
E14	14		U24U		G10	6		AC5H
E14	1		0C45		G10	9 & 10		F1CH
E14	2		320U		G10	12		0F96
E14	3		C530		G10	13		4U54
E14	4		1P02		G10	14		8233
E14	5		394A		G10	15		8H73
E14	6		8PP6					

## Schematic: SHT5

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
U7,R7	1	ROM	C443	S9	9	74LS157	/ 1285 /
T7,P7	2		FC92	S9	12		/ UUF5 /
	3		5PF5	R9	4	74LS157	/ 0A1F /
	4		A7U5	R9	7		/ H162 /
	5		UPAP	R9	9		/ FF86 /
	6		HA00	R9	12		/ FA45 /
	7		8066	P9	4	74LS157	/ 4473 /
	8		7211	P9	7		/ 3124 /
	18		473U	P9	9		/ A8PF /
	19		578F	P9	12		/ 4U1H /
	20		Lo	U9,T9	4,13	74LS75	/ 5AH4 /
	21		Lo	J14	13	74S288	/ 2AF1 /
	22		0499	J14	1		/ 86F5 /
	23		U62F	J14	2		/ UUPU /
				J14	3		/ A9P3 /
A8	8	74LS107	/ 0000 /	H14	1	74S02	/ 83UU /
A8	11		/ 0000 /	H14	5		/ 5AH4 /
A8	5		/ Hi /	H14	4		/ 5AH4 /
F10	6	74LS151	/ 61H3 /	H14	11		/ A98H /
A12	3	74LS32	/ 2AF1 /	H14	12		/ 8P9C /
S11	9	74LS163	/ 2AF1 /	H14	13		/ 5AH4 /
S11	15		/ 2F0H /	H14	10		/ HOU8 /
S11	11		/ 73HU /	I14	7,10	74LS163	/ 6HH2 /
S11	12		/ F745 /	I14	11		/ 87UC /
S11	13			I14	12		/ 6HH2 /
S11	14			U7,R7	1	PROMS	/ 4473 /
R11	9		/ 2AF1 /	T7,P7	2		/ FA45 /
R11	15		/ HA98 /		3		/ FF86 /
R11	11		/ P781 /		4		/ H162 /
R11	12		/ 8HA7 /		5		/ 0A1F /



R11	13		/ AC18 /			6		/ UUF5 /
R11	14		/ F55H /			7		/ 1285 /
P11	9		/ 2AF1 /			8		/ U801 /
P11	11		/ 7C77 /			19		/ 4U1H /
P11	12		/ 17UP /			22		/ A8PF /
P11	13		/ C962 /			23		/ 3124 /
P11	14		/ 9855 /					
S9	4	74LS157	/ 9515 /					
S9	7		/ U801 /					

Schematic: SHT5

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
F10	3	74LS151	30AP [ Hi ]	C10	11	74LS08	Lo
F10	2		018F	D10	12	74LS02	C32P
F10	1		8H73	D10	13		C32P
F10	9		4C4H	A8	1		32U4
F10	10		1F1A	A8	4		802H
F10	11		6H37	A8	2		49P2
F10	13		0F96	A8	3		49P2
F10	14		4U54	C8	12	74LS107	U6HH
F10	15		8233	C8	13		C32P
F10	6		F384 [61H3]	C8	3		9081
A12	2	74LS32	67AH	C8	11		665F
A12	3		390P [2AF1]	C8	8		C32P
				C8	10		Hi
C10	9	74LS08	2PFF	C8	6		C32P
C10	10		7341	C8	5		C32P
C10	8		U646				
B8	10	74LS107	C32P				
B8	11		6PF3	F12	1	7425	6H37
B8	5		19AP	F12	2		4819
B8	6		19AP	F12	4		1F1A
B8	1		409C	F12	5		FC4H
B8	4		802H	F12	6		8884
B8	2		4A50	I10	3	74LS00	0000 / PC9U
				D10	5	74LS02	67AH
E12	5	74LS04	5547	D10	4		FFC9
E12	6		5547	F12	10	7425	8884
A10	9	74LS00	2518	F12	12		C004
A10	10		51C4	F12	13		2518
A10	8		36C4	F12	8		774P
D12	3	74LS27	4819	D10	8		774P

D12	4		67AH		D10	9		6598
D12	5		36C4		D10	10		~12H6~
D12	6		Lo		A14	1	74S08	51C4
D12	9		5547		A14	2		32U4
D12	10		36C4		A14	3		12A8
D12	11		8PP6		B12	9	74LS10	2518
D12	8		Lo		B12	11		0F96
B10	13	74LS32	32U4		B12	8		C05P
B10	11		32U4		A12	6	74LS32	A76P

Schematic: SHT5

SHT6

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
K4	8	74LS02	CUH7	H8	5	74LS02	C530
K4	9		0UHA	H8	6		5547
K4	10		AA31	H8	4		403F
C12	1	74LS27	1P02	I8	12	74LS04	403F
C12	2		2518	G8	4	74LS107	6598
C12	12		C4AF	G8	2		239A
C12	3		2518	F8	9	74LS163	C530
C12	4		U6HH	F8	7		F9U6
C12	5		96UA	F8	1		C32P
C12	6		H47A	F8	15		F9U6
C12	10		774P	B6	4	74LS04	F9U6
C12	8		1798	H8	11	74LS02	F9U6
B12	3	74LS10	C32P	H8	12		239A
B12	4		FP05	H8	13		U97A
B12	5		1798	H8	8		5547
B12	6		077H	H8	9		C530
A10	12	74LS00	802H	H8	10		U50F
A10	11		802H	G8	11	74LS107	0109
A10	4		1798	G8	5		018F
A10	5		1846	G8	6		018F
A10	6		7890	A12	12	74LS32	018F
A10	1		6PF3	A12	13		F9U6
A10	3		6PF3	A12	11		204A
A6	5	74LS02	1846	I8	2	74LS04	204A
A6	6		U100	H8	1	74LS02	3980
A6	4		AAP8	J8	9	74LS86	F97P
A14	4	74S08	320U	J8	10		F6A4
A14	5		7341	J8	8		0UHA
A14	6		F567	J8	12		651H
A12	10	74LS32	0C45	J8	13		HAFA

A12	8		FP22		J8	11		CUH7
B14	9	74S32	F567		F6	3	74LS27	1P02
B14	8		4UHF		F6	6		6598
B14	1		774P		I8	10	74LS04	6598
B14	2		7323		H6	13	74LS164	9820
B14	3		UC77		J6	11	74LS10	9820
B14	5		F567		J2	3	74LS32	9820
B14	6		3P10		J2	12	74LS32	C9UC
					J2	11		2873

Schematic: SHT6

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
E8	10	74S288	A8F6	S2	4	74LS377	F6A4
E8	11		90P2	S2	14		HA32
E8	12		7U69	S2	13		F97P
E8	13		A19U	S2	17		0C22
E8	14		0495	S2	3		HAFA
E8	1		5C13	S2	7		UAC5
E8	2		26U2	S2	8		651H
E8	3		1825	S2	18		F567
E8	4		9890	S2	5		6P3U
E8	5		AUH7	S2	15		6P3U
E8	6		673F	S2	12		8A2A
E8	7		FH67	S2	16		6P3U
E6	1	74LS163	403F	S2	2		3796
E6	7		3980	S2	6		3796
E6	9		6598	S2	9		U366
E6	11		90P2	S2	19		1H2A
E6	12		9620	P2	1	74LS377	C530
E6	13		9170	P2	4		P38A
E6	14		A8F6	P2	14		30CC
E6	15		049C	P2	13		FUC5
D6	6	74LS163	A3U1	P2	17		725C
D6	11		PF0A	P2	3		9172
D6	12		A19U	P2	7		711H
D6	13		7U69	P2	8		FPF2
D6	14		FA81	P2	18		HAC9
D6	15		CH8U	P2	5		6P3U
C6	3	74LS163	1P24	P2	15		0000
C6	4		0495	P2	12		P415
C6	11		H3PU	P2	16		6P3U
C6	12		0495	P2	2		2ACF

C6	13		1P24		P2	6		1H2A
C6	14		A3U1		P2	9		C7P5
C6	15		0109		P2	19		AA58
					M2	1	74LS377	C530
U2	11	74S04	F6A4		M2	4		OU1F
U2	10		F6A4		M2	14		0841
U2	13		HAFA		M2	13		242C
U2	12		HAFA		M2	17		AC5H
S2	1	74LS377	C530		M2	3		26PP

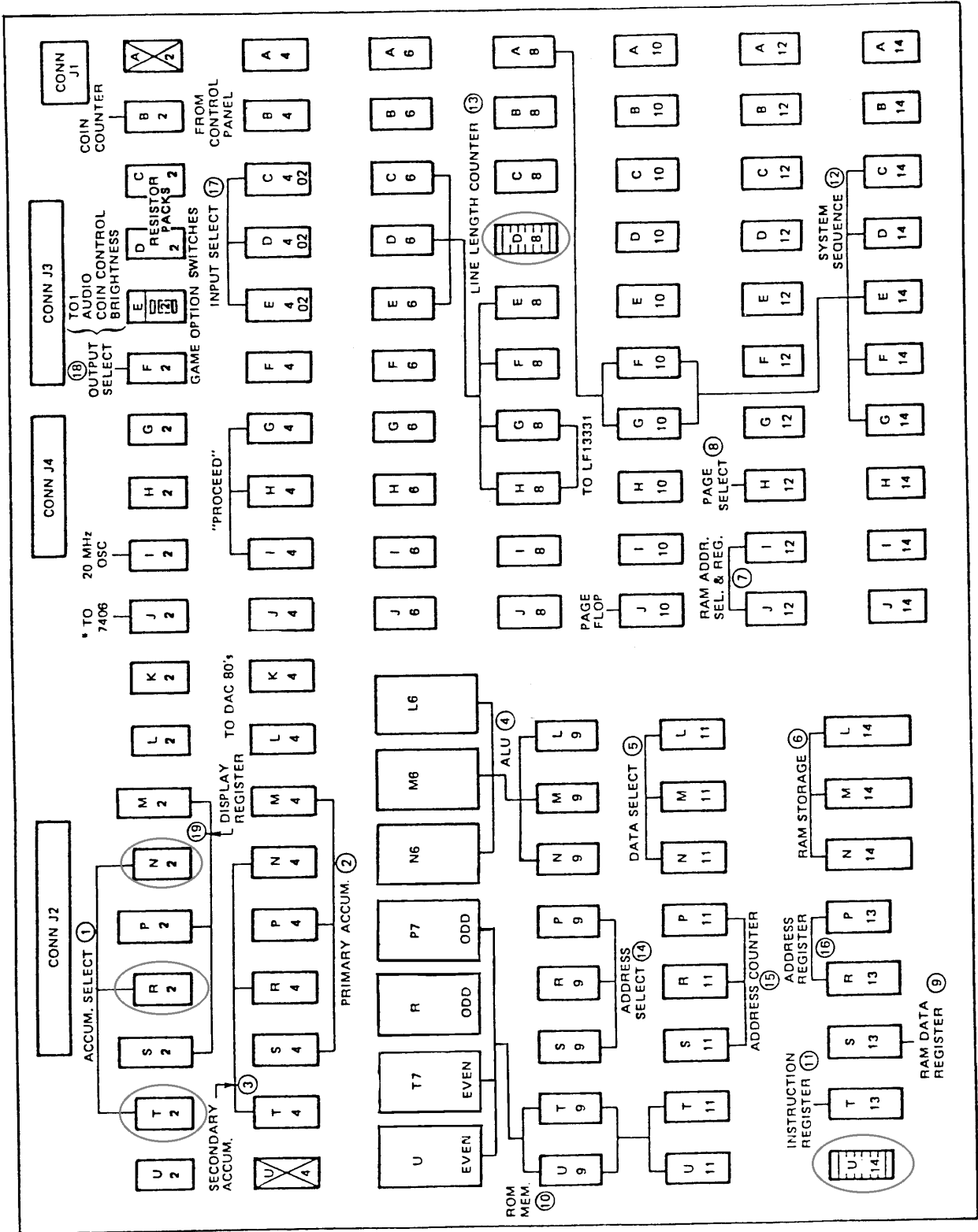
Schematic: SHT6

IC #	PIN #	IC TYPE	SIGNATURE	IC #	PIN #	IC TYPE	SIGNATURE
M2	7	74LS377	67HU				
M2	8		166U				
M2	18		C432				
M2	5		8A2A				
M2	15		6P3U				
M2	12		8A2A				
M2	16		0000				
M2	2		0000				
M2	6		C7P5				
M2	9		PP4F				
M2	19		0000				
-----	-----	-----	-----				




<b>clk1</b>	<b>CLOCK signal, will show 0000</b> signature
clk2	CLOCK signal, “
Hi	TTL level HIGH, “
Lo	TTL level LOW, “
nnnn / mmmm (button IN)	Lower (2 <sup>nd</sup> ) signature obtained with edge CLK
_nnnn	Signature obtained with J12 (& I12) pin 10 tied to GND
/nnnn/ removed)	Signature available with <i>NO JMI</i> option (jumper





## **EXAMPLES OF USEFUL MANUFACTURERS' LITERATURE**

Schematic Package #72-10626-02 Rev J, *C.P.U. Schematic Diagram with Signatures*, Cinematronics Inc.

Application Note AN-222-4, *Guidelines for Signature Analysis: Understanding the Signature Measurement*, Hewlett-Packard Inc., Publication Number 5952-7684.

Application Note AN-222-6, *Troubleshooting with Composite Signatures*, Hewlett-Packard Inc., Publication Number 5952-7684.