

## Supplement to



## Operators Manual (TM-241, 1st printing) and Schematic Package (SP-241, 1st printing)

This Supplement contains Crystal Castles game information and is intended to be used with the game manual (TM-241). The specific portions of TM-241 affected by the changes are referenced in this Supplement.

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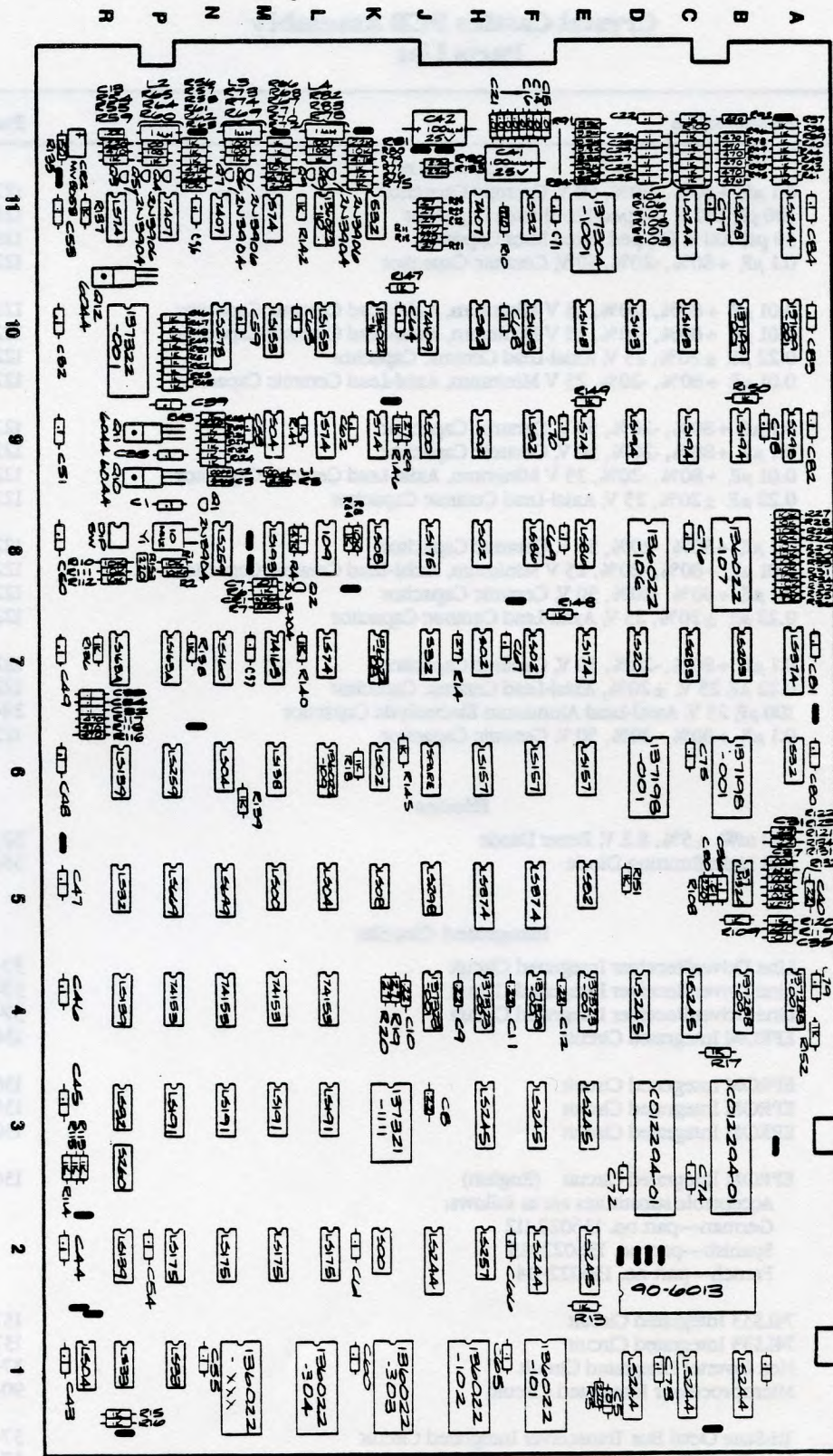


Figure 5-11 Crystal Castles PCB Assembly  
A039574-21 G



## Crystal Castles PCB Assembly Parts List

Designator	Description	Part No.
<b>Capacitors</b>		
C1	0.1 $\mu$ F, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C2	100 pF, 100 V, Dipped Fixed Mica Capacitor	128002-101
C3	39 pF, 100 V, Dipped Fixed Mica Capacitor	128002-390
C4	0.1 $\mu$ F, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C5	0.01 $\mu$ F, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C7	0.01 $\mu$ F, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C8-C13	0.22 $\mu$ F, $\pm$ 20%, 25 V, Axial-Lead Ceramic Capacitor	122004-224
C14-C21	0.01 $\mu$ F, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C22, C23	0.1 $\mu$ F, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C25-C29	0.1 $\mu$ F, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C30	0.01 $\mu$ F, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C31	0.22 $\mu$ F, $\pm$ 20%, 25 V, Axial-Lead Ceramic Capacitor	122004-224
C32-C34	0.1 $\mu$ F, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C35	0.01 $\mu$ F, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C36	0.1 $\mu$ F, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C37	0.22 $\mu$ F, $\pm$ 20%, 25 V, Axial-Lead Ceramic Capacitor	122004-224
C38, C39	0.1 $\mu$ F, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C40	0.22 $\mu$ F, 25 V, $\pm$ 20%, Axial-Lead Ceramic Capacitor	122004-224
C41, C42	100 $\mu$ F, 25 V, Axial-Lead Aluminum Electrolytic Capacitor	24-250107
C43-C85	0.1 $\mu$ F, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
<b>Diodes</b>		
CR1	500 mW, $\pm$ 5%, 8.2 V, Zener Diode	32-1N756A
CR2	Red Light-Emitting Diode	38-MV5053
<b>Integrated Circuits</b>		
1B	Line Driver/Receiver Integrated Circuit	37-74LS244
1C	Line Driver/Receiver Integrated Circuit	37-74LS244
1D	Line Driver/Receiver Integrated Circuit	37-74LS244
1F	EPROM Integrated Circuit	136022-101
1J	EPROM Integrated Circuit	136022-102
1K	EPROM Integrated Circuit	136022-303
1L	EPROM Integrated Circuit	136022-304
1N	EPROM Integrated Circuit (English) Acceptable substitutes are as follows: German—part no. 136022-112 Spanish—part no. 136022-113 French—part no. 136022-114	136022-305
1P	74LS33 Integrated Circuit	137239-001
1R	74LS33 Integrated Circuit	137239-001
1S	Hex Inverter Integrated Circuit	37-74LS04
2D	Microprocessor Integrated Circuit	90-6013
2E	Tri-State Octal Bus Transceiver Integrated Circuit	37-74LS245
2F	Line Driver/Receiver Integrated Circuit	37-74LS244
2H	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS257
2J	Line Driver/Receiver Integrated Circuit	37-74LS244

(continued on next page)



## Crystal Castles PCB Assembly Parts List, continued

Designator	Description	Part No.
2K	Quad 2-Input NAND Gate Integrated Circuit	37-74S00
2L	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS157
2M	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS157
2N	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS157
2P	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS157
2R	Dual 2-4 Decoder/Multiplexer Integrated Circuit	37-74LS139
3B	Custom Audio Integrated Circuit	C012294-01
3D	Custom Audio Integrated Circuit	C012294-01
3E	Tri-State Octal Bus Transceiver Integrated Circuit	37-74LS245
3F	Tri-State Octal Bus Transceiver Integrated Circuit	37-74LS245
3H	Tri-State Octal Bus Transceiver Integrated Circuit	37-74LS245
3K	Vertical Scroll Integrated Circuit	137321-1111
3L	Up/Down Counter Integrated Circuit	37-74LS191
3M	Up/Down Counter Integrated Circuit	37-74LS191
3N	Up/Down Counter Integrated Circuit	37-74LS191
3P	Up/Down Counter Integrated Circuit	37-74LS191
3R	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
4A, 4B	Non-Volatile RAM Integrated Circuit	137288-001
4C	Tri-State Octal Bus Transceiver Integrated Circuit	37-74LS245
4D	Tri-State Octal Bus Transceiver Integrated Circuit	37-74LS245
4E	16K × 4 RAM Integrated Circuit	137323-001
4F	16K × 4 RAM Integrated Circuit	137323-001
4H	16K × 4 RAM Integrated Circuit	137323-001
4J	16K × 4 RAM Integrated Circuit	137323-001
4L	Dual Data Selector/Multiplexer Integrated Circuit	37-74153
4M	Dual Data Selector/Multiplexer Integrated Circuit	37-74153
4N	Dual Data Selector/Multiplexer Integrated Circuit	37-74153
4P	Dual Data Selector/Multiplexer Integrated Circuit	37-74153
4R	Dual 2-4 Decoder/Multiplexer Integrated Circuit	37-74LS139
5B	Quad Op-Amp Integrated Circuit	37-LM324
5E	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
5F	Octal D-Type Flip-Flop Integrated Circuit	37-74LS374
5H	Octal D-Type Flip-Flop Integrated Circuit	37-74LS374
5J	Quad 2-Input, with Storage Multiplexer Integrated Circuit	137201-001
5K	Quad 2-Input AND Gate Integrated Circuit	37-74LS08
5L	Hex Inverter Integrated Circuit	37-74LS04
5M	Quad 2-Input NAND Gate Integrated Circuit	37-74LS00
5N	Up/Down Binary, Synchronous 4-Bit Counter Integrated Circuit	137109-001
5P	Up/Down Binary, Synchronous 4-Bit Counter Integrated Circuit	137109-001
5R	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
6A	Quad 2-Input OR Gate Integrated Circuit	37-74S32
6B	200 ns Tri-State Static RAM Integrated Circuit	137198-001
6D	200 ns Tri-State Static RAM Integrated Circuit	137198-001
6E	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS157
6F	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS157

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## Crystal Castles PCB Assembly Parts List, continued

Designator	Description	Part No.
6H	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS157
6K	Quad 2-Input NOR Gate Integrated Circuit	37-74LS02
6L	Bus PROM Integrated Circuit	136022-109
6M	3-8 Line Decoder/Multiplexer Integrated Circuit	137177-001
6N	Hex Inverter Integrated Circuit	37-74LS04
6P	8-Bit Latch Integrated Circuit	37-74LS259
6R	Dual 2-4 Decoder/Multiplexer Integrated Circuit	37-74LS139
7A	Octal D-Type Flip-Flop Integrated Circuit	37-74LS374
7B	4-Bit Binary, Full Adder Integrated Circuit	137204-001
7C	4-Bit Binary, Full Adder Integrated Circuit	137204-001
7D	Dual 4-Input NAND Gate Integrated Circuit	37-74LS20
7E	Hex D-Type Flip-Flop Integrated Circuit	37-74LS174
7F	Hex Inverter Integrated Circuit	37-74LS04
7H	Quad 2-Input NOR Gate Integrated Circuit	37-74S02
7J	Quad 2-Input OR Gate Integrated Circuit	37-74S32
7K	Synchronous PROM Integrated Circuit	136022-108
7L	Dual D-Type Flip-Flop Integrated Circuit	37-74LS74
7M	4-Bit Decade Counter Integrated Circuit	37-74163
7N	4-Bit Decade Counter Integrated Circuit	37-74LS160
7P	4-Bit Synchronous Counter Integrated Circuit	37-74LS163A
7R	4-Bit Synchronous Counter Integrated Circuit	37-74LS163A
8B	EPROM Integrated Circuit	136022-106
8D	EPROM Integrated Circuit	136022-107
8E	Quad 2-Input Exclusive OR Gate Integrated Circuit	37-74LS86
8F	Quad 2-Input Exclusive OR Gate Integrated Circuit	37-74LS86
8H	Quad 2-Input NOR Gate Integrated Circuit	37-74S02
8J	Quad D-Type Flip-Flop Integrated Circuit	37-74LS175
8K	Quad 2-Input AND Gate Integrated Circuit	37-74LS08
8L	Dual J-K Flip-Flop Integrated Circuit	37-74109
8M	Up/Down Counter Integrated Circuit	37-74LS193
8N	8-Bit Latch Integrated Circuit	37-74LS259
9A	Quad 2-Input, with Storage Multiplexer Integrated Circuit	137201-001
9B	Shift Register Integrated Circuit	37-74LS194
9C	Shift Register Integrated Circuit	37-74LS194
9D	Shift Register Integrated Circuit	37-74LS194
9E	Dual D-Type Flip-Flop Integrated Circuit	37-74LS74
9F	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
9H	Quad 2-Input NOR Gate Integrated Circuit	37-74LS02
9J	Quad 2-Input NAND Gate Integrated Circuit	37-74LS00
9K	Dual D-Type Flip-Flop Integrated Circuit	37-74S74
9L	Dual D-Type Flip-Flop Integrated Circuit	37-74S74
9M	Hex Inverter Integrated Circuit	37-74S04
10A	55 ns Tri-State Static RAM Integrated Circuit	137199-001
10B	55 ns Tri-State Static RAM Integrated Circuit	137199-001

(continued on next page)



## Crystal Castles PCB Assembly Parts List, continued

Designator	Description	Part No.
10C	4-Bit Synchronous Counter Integrated Circuit	37-74LS163A
10D	4-Bit Synchronous Counter Integrated Circuit	37-74LS163A
10E	4-Bit Synchronous Counter Integrated Circuit	37-74LS163A
10F	4-Bit Synchronous Counter Integrated Circuit	37-74LS163A
10H	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
10J	Dual J-K Flip-Flop Integrated Circuit	37-74109
10K	Color PROM Integrated Circuit	136022-111
10L	4 to 1 Data Selector/Multiplexer Integrated Circuit	37-74LS153
10M	4 to 1 Data Selector/Multiplexer Integrated Circuit	37-74LS153
10N	Octal D-Type Flip-Flop Integrated Circuit	37-74LS273
10R	64 x 9 RAM Integrated Circuit	137322-001
11A	Line Driver/Receiver Integrated Circuit	37-74LS244
11B	Quad 2-Input, with Storage Multiplexer Integrated Circuit	137201-001
11C	Line Driver/Receiver Integrated Circuit	37-74LS244
11E	Trak-Ball Interface Integrated Circuit	137304-1001
11F	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
11H	Hex Buffer/Driver Integrated Circuit	37-7407
11K	Quad 2-Input OR Gate Integrated Circuit	37-74S32
11L	Write PROM Integrated Circuit	136022-110
11M	Dual D-Type Flip-Flop Integrated Circuit	37-74S74
11N	Hex Buffer/Driver Integrated Circuit	37-7407
11P	Hex Buffer/Driver Integrated Circuit	37-7407
2/3R	Dual 5-Input NOR Gate Integrated Circuit	37-74S260
11R	Dual D-Type Flip-Flop Integrated Circuit	37-74LS74
<b>Resistors</b>		
R1, R2	10 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-103
R3	220 $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-221
R4	4.7 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-472
R5	220 $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-221
R6	1 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-102
R7	220 $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-221
R8	10 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-103
R9	27 $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-270
R10-R12	220 $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-221
R13	1 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-102
R14	27 $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-270
R15-R18	1 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-102
R19-R24	27 $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-270
R25-R36	10 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-103
R37-R53	1 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-102
R54	220 $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-221
R55	1.2 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-122
R56-R60	1 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-102
R61	4.7 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-472
R62	22 k $\Omega$ , $\pm 5\%$ , $\frac{1}{4}$ W Resistor	110000-223

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## Crystal Castles PCB Assembly Parts List, continued

Designator	Description	Part No.
R63	10 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-103
R64, R65	100 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-101
R66-R69	1 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-102
R70	4.7 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-472
R71	10 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-103
R72	22 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-223
R73, R74	100 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-101
R75-R78	1 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-102
R79	4.7 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-472
R80	10 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-103
R81	22 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-223
R82, R83	100 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-101
R84-R91	3.3 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-332
R92, R93	470 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-471
R95-R99	470 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-471
R100, R101	1 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-102
R103-R107	1 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-102
R108	220 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-221
R109	1 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-102
R110-R112	10 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-103
R113-R115	1 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-102
R116-R118	470 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-471
R119	220 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-221
R120	1 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-102
R121, R122	100 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-104
R123	62 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-623
R124-R127	1 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-102
R128	220 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-221
R129	1 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-102
R130	2.2 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-222
R131, R132	100 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-104
R133	2.2 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-222
R134	100 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-104
R135	150 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-151
R136-R152	1 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-102
R153	220 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-221
<b>Sockets</b>		
1F	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
1J	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
1K	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
1L	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
1N	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
2D	40 Contact, Medium-Insertion-Force IC Socket	79-42C40
3B	40 Contact, Medium-Insertion-Force IC Socket	79-42C40
3D	40 Contact, Medium-Insertion-Force IC Socket	79-42C40

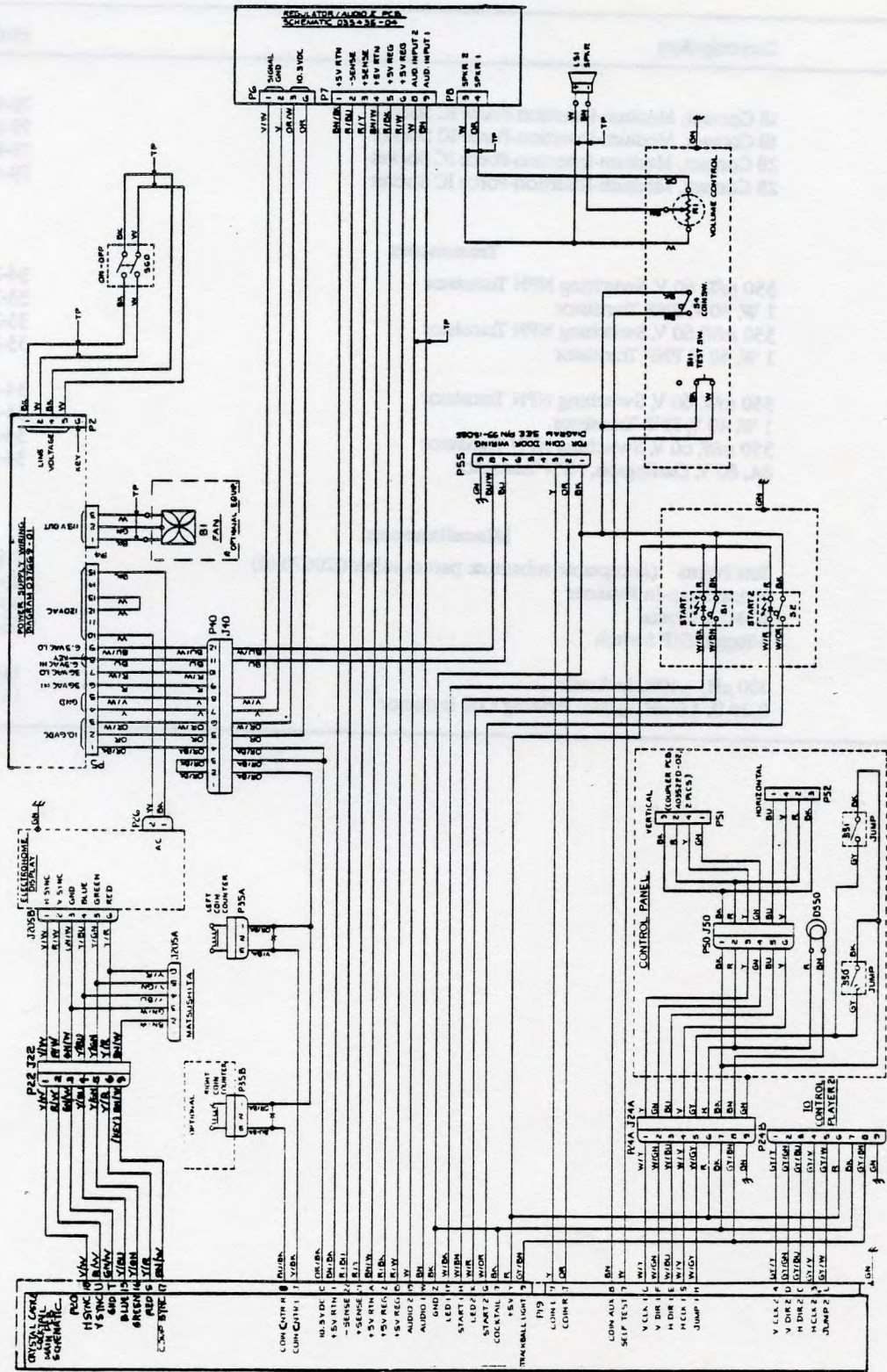
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## Crystal Castles PCB Assembly Parts List, continued

Designator	Description	Part No.
4A	18 Contact, Medium-Insertion-Force IC Socket	79-42C18
4B	18 Contact, Medium-Insertion-Force IC Socket	79-42C18
8B	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
8D	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
<b>Transistors</b>		
Q1-Q3	350 mW, 60 V, Switching NPN Transistor	34-2N3904
Q4	1 W, 40 V, PNP Transistor	33-2N3906
Q5	350 mW, 60 V, Switching NPN Transistor	33-2N3904
Q6	1 W, 40 V, PNP Transistor	33-2N3906
Q7	350 mW, 60 V, Switching NPN Transistor	34-2N3904
Q8	1 W, 40 V, PNP Transistor	33-2N3906
Q9	350 mW, 60 V, Switching NPN Transistor	34-2N3904
Q10-Q12	8A, 80 V, Darlington, NPN Transistor	34-2N6044
<b>Miscellaneous</b>		
	Test Points (Acceptable substitute part number 020670-01)	179051-002
	Nylon Snap-In Fastener	81-4302
Y1	10-MHz Crystal	90-123
8R	4-Toggle DIP Switch	66-114P1T
L1	100 $\mu$ H, $\pm$ 10% Inductor	141002-001
L2-L4	0.29 $\Omega$ , 1.0 $\mu$ H, $\pm$ 10% Peaking Coil Inductor	141007-001



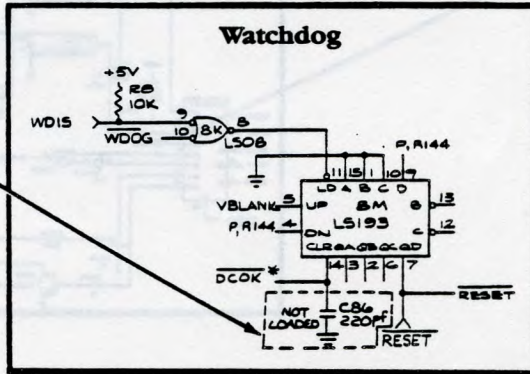


Crystal Castles Cocktail  
Main Wiring Diagram 041132-01 A



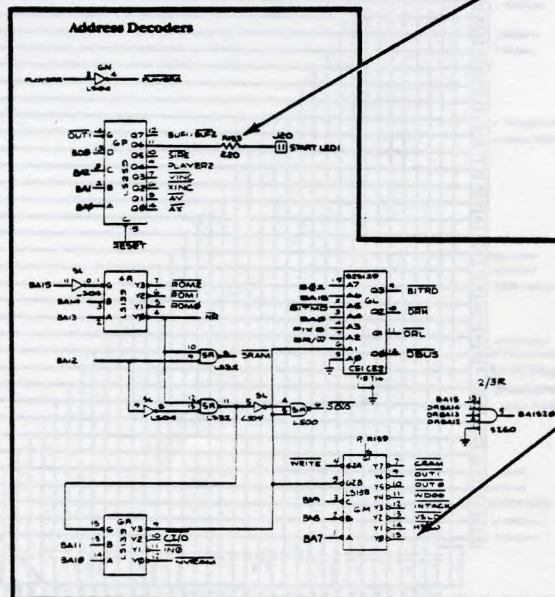
SHEET 4A-WATCHDOG

C86, 220 pF (not loaded)  
was added to Pin 14 of 8M.



SHEET 4B-ADDRESS DECODER

R153 was added at Pin 11 of 6P.

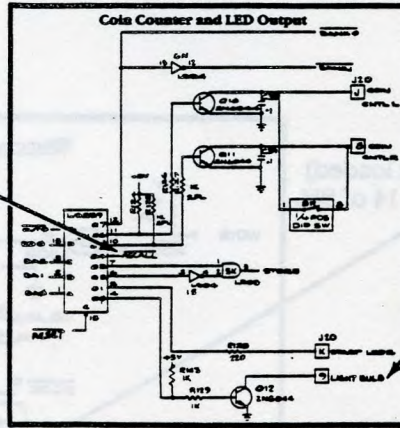


Signal name RECALL was deleted  
from Pin 15 of 6M.



**SHEET 8B-COIN COUNTER AND LED OUTPUT**

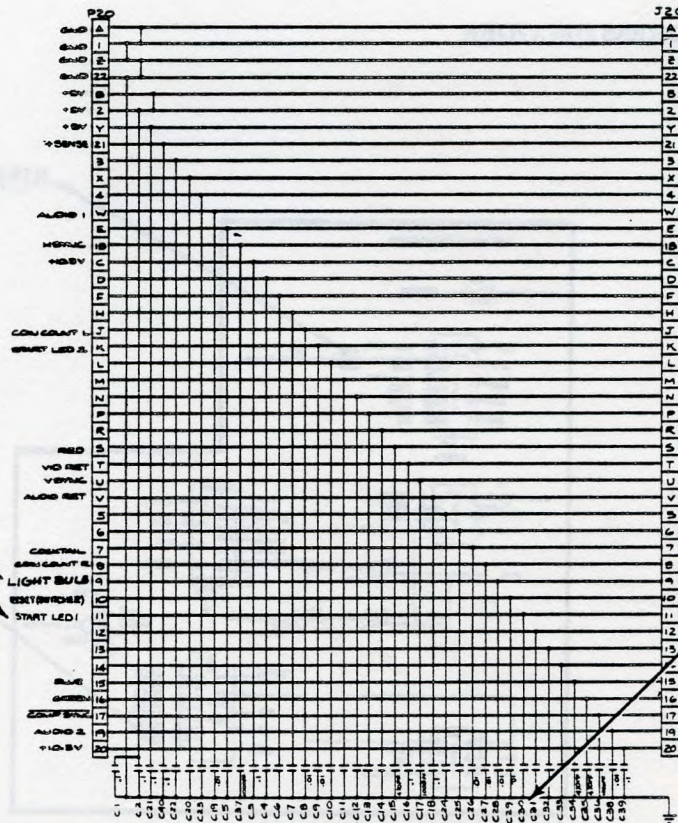
Signal name RECALL was added at Pin 9 of 8N



Signal name LED 1 changed to LIGHT BULB at Pin 9, Connector J20.

**SHEET 9A-EMI SHIELD**

Signal name START LED 1 was moved to Pin 11 of Connector P20. Signal name LIGHT BULB was added at Pin 9.



C30 is no longer loaded.