

Development Cartridges For The Atari 7800 Development System

devcarts.pdf - Rev. 14/2003

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Table of Contents

1. Introduction.....	3
1.1 Where to find the most recent documentation.....	3
1.2 Summary.....	3
1.3 Choosing between a DevOS Console & Ramona Dev Carts.....	5
1.4 Making bigger 7800 Dev Carts.....	5
1.5 Making bigger 2600 Dev Carts.....	5
2. How to modify a PAL 7800 Console.....	6
2.1 Console Specification.....	6
2.2 The DevOS BIOS Chip.....	6
2.3 Installing the DevOS BIOS Chip.....	6
3. How to get sound from an NTSC console when using a PAL TV.....	6
3.1 Atari 7800.....	6
3.2 Atari 2600 Jnr.....	6
4. Parts required for Dev Cart Mods.....	7
4.1 A suitable Atari 7800 Game Cartridge.....	7
4.2 32Kx8, 64Kx8 or 128Kx8 Static Random Access Memory (SRAM).....	7
4.3 Jumper Wire.....	7
4.4 Capacitors.....	7
5. Dev Cart Construction Tips.....	8
6. 32K/48K Linear Dev Cart.....	9
7. 32K "Pokey" Dev Cart.....	9
8. Making use of built-in RAM.....	10
9. FlashROM Socketed Dev Cart.....	10
10. 144K Bankswitching Dev Cart.....	11
11. 64K/144K Bankswitching Dev Cart with Built-in BIOS.....	14
11.1 Modifying Game Cartridge PCB Type C300565-XXX.....	14
11.2 Modifying Game Cartridge PCB Type C100339.....	16
12. Combined 2K/4K & 8K/F8 Bankswitching Dev Cart.....	18
13. Combined 8K/F8 & 16K/F6 Bankswitching Dev Cart with SC RAM.....	20
14. Combined 2K/4K & 32K/F4 Bankswitching Dev Cart with SC RAM.....	22
15. Linear 2K/4K Dev Cart with Built-in BIOS.....	23
16. Combined 2K/4K, 8K/F8 & 16K/F6 Bankswitching Dev Cart with Built-in BIOS.....	24
17. Appendix.....	26
17.1 Circuit Diagram for PCB No. C300565-XXX.....	26
17.2 Circuit Diagram for PCB No. C100339.....	27
17.3 Logic Diagrams.....	28
17.3.1 Atari Super Game Cartridge Logic.....	29
17.3.2 Dev Cart Logic.....	30
18. Acknowledgments.....	38

1. Introduction

1.1 Where to find the most recent documentation

This document has been written as a supplement to instructions for making the Atari 7800 Development System and cart dumper by John Saeger and Eckhard Stolberg.

For the most recent version of the system mod instructions refer to:-

<http://home.arcor.de/estolberg/tools/index.html>

Or search for "7800 development system"

For the most recent version of this document (devcards.pdf) refer to:-

<http://www.geocities.com/gjp57/download.htm>

1.2 Summary

First in this document is a description of how a PAL 7800 console was fitted with a DevOS BIOS rom chip. The console was originally purchased in Australia (with the built in game Asteroids).

Secondly, a number of development cartridge modifications are described. For the most part they require a common cartridge PCB like that found in Choplifter (PAL). The simplest 48K dev cart requires only one jumper whilst a 144K bankswitching dev cart can be built with as few as seven jumpers.

With a good range of dev carts supporting the predominant 2600 software formats, the 7800 development system is now equally at home hosting 2600 binaries. Further, it is no longer essential to modify your 7800 console since a dev cart with built in "Ramona" BIOS can be used on a stock 7800 console.

A complete summary of dev cart game support is given in Table 1.

\ Game Type Dev Cart	7816	7832	7848	78S4 (64K)	78SG (128K)	78S9 (144K)	262K ⁽²⁾	264K	26FE ⁽⁵⁾ (8K)	26F8 (8K)	26S8 (RAM)	26F6 (16K)	26S6 (RAM)	26F4 (32K)	26S4 (RAM)
32K Linear ⁽⁷⁾	✓	✓	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗
32K Linear FlashROM ⁽⁸⁾	✓	✓	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗
32K Linear "Pokey" ⁽⁷⁾	✓	✓	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗
48K Linear ⁽⁷⁾	✓	✓	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗
64K Bankswitching	✓	✓	✓ ⁽³⁾	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗
144K Bankswitching	✓	✓	✓ ⁽³⁾	✓ ⁽⁴⁾	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗

2K/4K	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗
2K/4K & 8K/F8	✗	✗	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	✗	✗	✗
2K/4K, 8K/F8 & 16K/F6	✗	✗	✗	✗	✗	✗	✓	✓	✗	✓	✗	✓	✗	✗	✗
8K/F8 & 16K/F6 with RAM ⁽⁶⁾	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✗	✗
2K/4K & 32K/F4 with RAM ^(6,7)	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✓	✓

Table 1 Summary of Game Type Support

Note 1: A Grey tick indicates partial support.

Note 2: Requires use of the -d switch during upload.

Note 3: Super Huey UH-IX requires use of the -d switch during upload.

Note 4: Tank Command & Pitfighter require use of the -d switch during upload.

Note 5: Requires use of the -r switch during upload. (Robot Tank and Decathlon are type 26FE).

Note 6: Requires use of the -f switch during upload (requires DevOS version 0.2).

Note 7: Requires use of the -c1 switch during upload.

Note 8: Requires use of the -c3 switch during upload.

1.3 Choosing between a DevOS Console & Ramona Dev Carts

There is a choice to be made between modifying a 7800 console with the DevOS BIOS, or building Ramona dev carts to use on an unmodified 7800 console. Either way you will require a programmed EPROM (DevOS BIOS or Ramona BIOS) and a computer link cable.

See Table 2 below for a comparison of the two:-

Using a DevOS Console	Using Ramona Dev Carts
Modifying console may be tricky (especially NTSC)	No need to risk modifying a console
Video standard (NTSC/PAL) depends on console modified	Ramona carts work equally well on NTSC or PAL consoles
Can dump 2600 and 7800 ROM images off game cartridges	Cannot dump ROM images
Standard dev carts are simpler to build	Equivalent Ramona dev carts are more complex to build
Best range of dev cart designs	Some dev carts are not available with Ramona BIOS. ie. Pokey, FlashROM, 2600 with SC RAM
Can upload and play 2600 and 7800 games	Can upload and play 2600 and 7800 games

Table 2 Comparison of the DevOS console with Ramona Dev Carts

1.4 Making bigger 7800 Dev Carts

It is possible to build much larger dev carts. Atari's bankswitching scheme for the 7800 can be expanded easily using existing cartridge logic.

Bank numbers selected by game software are stored in the cartridge flip-flop as a binary number with each digit controlling a banked address line. On a standard 128K game, the first three data lines (D0,D1 & D2) are stored giving 8 defined banks of 16K. However, as many as eight data lines can be stored in the cartridge flip-flop yielding an eight digit binary bank number, or 256 defined banks of 16K each. That's 4 MBytes of total game space!

eg. To double SRAM size from 128K to 256K, jumper D3 to an unused flip-flop input. Jumper the matching flip-flop output to the new SRAM address line. Also, using a pull-up resistor, jumper the new address line to +5V. (To select the top 16K bank when flip-flop output is disabled).

To use anything larger than 128K requires that support be written in to 7800ctrl.exe.

1.5 Making bigger 2600 Dev Carts

It is also possible to build larger 2600 dev carts but this is not as straight forward as with 7800 software. There is no existing bankswitching scheme for the 2600 that can be expanded simply, instead it is necessary to propose new bankswitching schemes which will be suitable. In particular, bankswitching hot-spots should not conflict with processor start up vectors which are near the top of the available ROM address space.

I propose that up to 256 banks of 4K each could be controlled using a single 74LS374 flip flop. Also, going larger with more banking hot spots has the advantage of simplifying hot spot detection.

I suggest the schemes described in Table 3 below.

Any of the proposed bankswitching schemes can be used in conjunction with Super Chip RAM.

Note also that 7800ctrl.exe could be used to upload to 64K or 128K dev carts without modification.

Diminishing Returns

Bear in mind that hot-spots cannot be used to hold useful data in the game ROM image. The loss of useful space from each bank is equal to the actual number of banks (in bytes per bank). eg. On a 64K game 16 bytes would be lost from every 4K bank, and if the programmer didn't care to use the space available above the hot-spots then the loss is virtually doubled.

In addition, use of 128 bytes of Super Chip RAM makes the first 256 bytes of each 4K bank unuseable.

Size	Hot Spot Address Range	Short Hand Designation	Designation with SC.RAM	Test for Hot-Spot Detection	No. Of Banks	Bank No. defined by:-
64K	\$1FE0 - \$1FEF	EF	SE	A4=0 & A5 to A12=1	16	A0 - A3
128K	\$1FC0 - \$1FDF	DF	SD	A5=0 & A6 to A12=1	32	A0 - A4
256K	\$1F80 - \$1FBF	BF	SB	A6=0 & A7 to A12=1	64	A0 - A5
512K	\$1F00 - \$1F7F	7F	S7	A7=0 & A8 to A12=1	128	A0 - A6
1M	\$1E00 - \$1EFF	FF	SF	A8=0 & A9 to A12=1	256	A0 - A7

Table 3 Proposed Bankswitching Schemes for Atari 2600 Games larger than 32K

2. How to modify a PAL 7800 Console

2.1 Console Specification

Atari Model No.7800 PAL B

Made in China

S/No. A1(084)5029749

Motherboard P/No. C300633-001 Rev C

2.2 The DevOS BIOS Chip

The following EPROMs have been used successfully for console conversion:-

24-pin 4K (2732)

28-pin 8K, 16K, & 32K (DevOS copied to last 4K)

2.3 Installing the DevOS BIOS Chip

- Remove component W6 and install at location W5. (W6 is in the front-right corner of the motherboard).
- For a 24-pin eprom only, remove component W2 and install at location W3. (W2 is located to the left of the socketed BIOS chip).
- Remove the original BIOS chip (P/No. C300558-001) from it's socket. Insert the new BIOS chip with the same orientation. For a 24-pin eprom, install at the extreme right of the socket.

BTW, the built in game is not supported by the DevOS BIOS.

3. How to get sound from an NTSC console when using a PAL TV

If you are using an NTSC Atari 2600 or 7800 console on a PAL TV and cannot get sound, then help is at hand. (This can even be a problem with an "NTSC ready" TV).

3.1 Atari 7800

Near the left end of the cartridge slot is an adjustable inductor (R.F.choke) L2 which is used to set the sound carrier frequency. The range of adjustment, however, is not sufficient to alter tuning for a PAL TV. Immediately to the right of L2 is another inductor, L3 which needs to be reduced in value:-

- Either replace L3 with a 1.0 μ H inductor, or jumper a 2.2 μ H inductor across L3.
- Tune your TV for best picture quality then using a non-conductive 2mm hex driver adjust L2 for best sound.

3.2 Atari 2600 Jnr

Locate L8 which is an adjustable inductor in a square metal shell. This can be accessed through holes in the top and bottom of the motherboard shielding in the very front-right corner. (Not the orange plastic inductor). L8 is used to set the sound carrier frequency:-

- Tune your TV for best picture quality then using a small non-conductive flat tipped driver adjust L8 for best sound. (Expect to turn C.W. from the factory setting).

4. Parts required for Dev Cart Mods

4.1 A suitable Atari 7800 Game Cartridge

Except for the "Pokey" Dev Cart which requires a Ballblazer cartridge, all modifications shown were originally based on the Printed Circuit Board part No.C300565-XXX. (The 64K/144K Bankswitching dev cart with built-in BIOS can also be made from a C100339 PCB).

An Atari 7800 PAL game cartridge "Choplifter" was used for original modifications. PAL games which are known to use this PCB are:-

Alien Brigade ⁽¹⁾	Hat Trick
Barnyard Blaster	Impossible Mission ⁽²⁾
Choplifter	Jinks ^(2, 3)
Crossbow ⁽¹⁾	Joust
Desert Falcon	Mario Bros.
Donkey Kong	One On One
Donkey Kong Jnr	Super Huey
Food Fight	Tower Toppler ⁽²⁾
Galaga	Xevious

Table 4

NTSC games which are known to use this PCB:-

Barnyard Blaster	Jinks ⁽²⁾
Crack'ed	Tower Toppler ⁽²⁾
Dark Chambers	Winter Games ^(4, 5)

Table 5

Notes:-

- (1) Additional 16K ROM at U2
- (2) At least 8K RAM at U2
- (3) IMS1630-PL70 chip at U2
- (4) 16K or 32K RAM chip at U2
- (5) CXK58256P-12L chip at U2

4.2 32Kx8, 64Kx8 or 128Kx8 Static Random Access Memory (SRAM)

In original modifications, cache and cmos memory from 486 and Pentium motherboards was used. These SRAM chips are generally 7.6mm wide. Every type tried was found to work fine, although I did come across a couple of dud chips.

Most dev cart designs shown here rely on Write Enable (WE-) over-riding Output Enable (OE-) during write cycles. This works fine with all SRAMs tested to date.

The following types were used successfully (32K 28-pin unless noted):-

MANUFACTURER	PART No.
Alliance	AS7C256-20PC
Alliance (64K 32-pin)	AS7C3512-15PC
AT & T	ATT7C199P-20
Cypress	CY7C199-20PC
EtronTech	Em51256C-15PL
Integrated Device Technology	IDT71256-S25TP
ISSI	IS61C256A-20N
Matra MHS	HM3-65756F-5
Micron	MT5C2568-20
Mosel	MS62256A-25NC
Motorola	MCM6206DP20
Samsung	KM68V257CP-15
Samsung (128K 32-pin)	K6T1008C2C-DB55
Toshiba	TC55328AP-20
United Microelectronics Corp.	UM61256K-15
Winbond (16K 28-pin)	W24129AK-15
Winbond	W24257AK-15
Winbond (64K 32-pin)	W24512AK-20

Table 6

4.3 Jumper Wire

Plain copper stranded wire with PVC sheath. Typically a light duty hook-up wire 27 to 24 a.w.g. (0.11 - 0.22 squ.mm). (Suitable wire can usually be found by stripping an old computer printer cable).

4.4 Capacitors

All capacitors fitted to dev carts are the ceramic type 0.1 μ F ("104"). If you are using a C100339 PCB then the type with axial leads fits best. (There are several of these on an Atari 2600 console).

5. Dev Cart Construction Tips

- Always hold the Printed Circuit Board (PCB) in a vice or with a small clamp when soldering. If your vice has metal jaws then use duct tape to attach some scrap plywood to them. If you do not have a vice, then use a small clamp and some scrap ply packing to clamp the PCB to the edge of a table top. Use no more clamping force than is necessary to hold the PCB firmly.
- When removing IC chips from the PCB, file through the chip pins right next to the chip body. Remaining pin legs can then be easily removed one at a time. (If the chip location is to remain vacant then there is no need to remove the remaining pin legs).

If you have a solder sucker then chips can be removed intact and reused if required. Heat each pin near the top surface of the PCB. When the solder liquefies apply suction over the pin on the bottom surface of the PCB. Inspect each pin hole for absence of solder then move the pin back and forth using a small screwdriver to ensure it is free. When all pins are free it will be possible to coax the chip from the PCB. Do not use force as the PCB traces may be torn from the PCB surface.

- When a PCB jumper is required to be open (not bridged) simply suck all the solder from it. On some PCBs the jumpers are bridged by a small trace that is not obvious. If so, then cut or file these traces through.
- If a logic chip or chip socket is to be fitted then you will require a solder sucker to clear the pin holes. The hand held variety is good value.
- When logic or memory chip pins are to be bent up to horizontal always trim off the narrow part of these pins. This leaves small flaps that are less likely to cause physical interference or an electrical short. Always solder all remaining vertical pins to the matching bottom chip pins.
- Wherever logic or memory chips are stacked two high, allow the first installed chip to cool completely before installing the second chip. Route jumpers around stacked chips to allow for clearance inside the cartridge case.
- Use resin cored solder 1mm diameter or smaller.
- The application of a smooth coating of solder to the soldering iron tip is referred to as tinning. A coating of solder on the tip will prevent oxides forming and is an efficient conductor of heat. A new soldering iron tip should be tinned prior to use and periodically thereafter. Leave a generous coating of solder on the tip each time you switch off.

How to tin a soldering iron tip:-

Start with a clean tip. If the tip has become oxidized and won't wet then carefully file away oxidized material leaving bare metal. Switch the iron on and apply a coating of solder over the whole surface of the tip as soon as it's hot enough to melt the solder. (Do not delay in applying solder as oxides will form if the uncoated tip gets too hot). Clean off excess solder with a damp cloth.

- Work quickly when soldering delicate parts such as logic chips and SRAM.
- When soldering a connection, use the iron to heat the parts being joined. Feed solder directly into the joint. (Do not feed solder onto the iron as this can result in a "cold" soldered joint which may fail later). eg. Attaching a jumper to a pin:-
 - PCB in vice or clamped firmly.
 - Hold jumper against pin.
 - Lightly press iron tip against wire and pin to hold and heat.
 - Use free hand to apply solder to wire & pin.
 - Hold jumper steady against pin while iron is removed & joint solidifies.

If required, parts to be connected can be wetted individually prior to joining.

- When bridging across pins on a logic chip, feed solder onto each pin near the chip body. With a small bead on each pin bridge across the pins with the iron and the beads will join. (This works even if one pin is bent up and the other is down).
- Troubleshooting; some potential pitfalls:-
 - A construction step that has been missed or only partially completed.
 - A missed connection. Sometimes solder that has been fed onto two parts to be joined will make two small beads that are not connected.
 - Loose solder or unintended bridges of solder causing a short.
 - A broken trace. (Bypass with a jumper to the nearest junction).
 - Incorrect orientation of logic chip or SRAM. (An SRAM installed end for end will crash the console).
 - Pin numbers interpreted incorrectly. eg. If you are installing a 32-pin chip over a chip location with only 28 holes then pin numbers and hole numbers will not correspond. (Actual pin numbers, and actual hole numbers are always used in these instructions).
 - A faulty SRAM or logic chip.

6. 32K/48K Linear Dev Cart

MODIFYING THE GAME CARTRIDGE:-

- 1) Remove U1,U2 and U5.
- 2) This modification requires a 74LS02 logic chip at U3 and a 74LS00 logic chip at U4. Fit as required.
- 3) Ensure that R1 and C2 are fitted. Use a zero Ohm link or wire jumper at R1. If you plan on fitting a 32 pin SRAM (64Kx8 or 128Kx8) then locate R1 and C2 on the back of the PCB.

Remove all other Resistors and capacitors.

Follow remaining instructions for the SRAMs you have chosen:-

USING ONE 32Kx8 SRAM (32K)

- 4) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U2. Bend pins 20(CS-) and 22(OE-) up to horizontal then install at U2.
- 5) Jumper U3 pin 13 to U2 pins 20 & 22 (CS- &OE-).

USING ONE 64Kx8 OR 128Kx8 SRAM (48K)

- 4) Take a 32 pin, 64K or 128K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U2. Bend pins 1(NC), 2(A16), 22(CS-), 24(OE-), 31(A15) and 32(Vcc) up to horizontal then install at U2 with pin 3 in hole 1.
- 5) Jumper U3 pin 13 to U2 pins 22 & 24 (CS- & OE-).
- 6) Jumper U2 pin 30 to pin 32(Vcc).
- 7) Jumper U2 pin 31(A15) to U4 pin 5 (A15).
- 8) If you are using a 128Kx8 SRAM then Jumper U2 pin 2(A16) to pin 16(GND).

USING TWO 32Kx8 SRAMS (48K)

- 4) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U2. Install at U2.
- 5) Take a (second) 28 pin, 32K SRAM chip and bend the very ends (the last 2mm) of all the pins out to approximately 45 deg. This chip is to sit piggy-backed over the first 32K SRAM chip installed at U2 (per step #4). Bend pins 20(CS-) and 22(OE-) up to horizontal.

Install the second chip directly on top of the first. All but pins 20(CS-) and 22(OE-) are to be soldered to matching pins on the first chip.

- 6) Jumper U3 pin 4(A15-) to U2(Top) pins 20 & 22 (CS- & OE-).

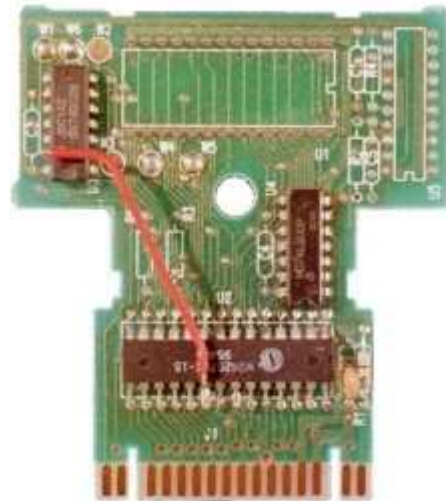


Figure 1 Using two 32Kx8 SRAMs

7. 32K "Pokey" Dev Cart

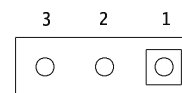
This development cartridge supports 7800 programs that use Atari's multi-purpose Pokey chip. It also supports the same games as a regular 32K cart.

DESIGN:-

- 1) A Ballblazer cartridge is required for this modification, PCB part number C026461. Atari's Pokey chip comes fitted at U3.
- 2) The memory size is limited to 32K because the Pokey chip uses the first 16k of the available 48K memory address space.

MODIFYING THE GAME CARTRIDGE:-

- 1) Remove U1.
- 2) Move the jumper at W1 from [1-2] to [2-3].
Legend:-



- 3) Remove jumpers at W2 and W3.
- 4) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U1. Install at U1.
- 5) Take a 74LS00 logic chip, bend pin 2 up to horizontal then install at U2. (Note:- Chip pins 1 and 14 are at the top end of the PCB).
- 6) Jumper U2 pin 8 to W2 hole 2(WE-).
- 7) Jumper U2 pin 9 to U3(Pokey) pin 7(CLK2).
- 8) Jumper U2 pin 12 to W2 hole 3(R/W).
- 9) Bridge U2 pin 1 to 2, pin 10 to 11 and pin 12 to 13.
- 10) On the back of the PCB, bridge U2 hole 2 to pin 3(CS-).

8. Making use of built-in RAM

A few of Atari's 7800 game cartridges come with a RAM chip fitted in U2. (eg. Jinks, Tower Toppler, Winter Games). It is possible to make use of this RAM chip.

Start by completing steps 1 through 3 of the 32K/48K linear dev cart mod detailed above. (Without removing the RAM at U2).

Finally, complete steps detailed below:-

DEV CART USING EXISTING RAM CHIP

- U2 hole 20 is connected by a single trace to U4 pin 3. (This is the only trace connecting to U4 pin 3). Locate this trace on the back of the PCB in the vicinity of U4 and cut or file it through.
- Jumper U2(RAM) pin 20(CS-) to U3 pin 4 (A15-).

The size of the dev cart will depend on the size of the original RAM chip fitted to the board.

DEV CART USING EXISTING RAM CHIP PLUS ADDITIONAL 16K/32K SRAM

This mod is only useful when there is 32K of RAM already fitted at U2, in which case you will finish with a 48K dev cart. (eg. Using a Summer or Winter Games cart).

- Take a 28 pin, 16K or 32K SRAM chip and bend the pins out almost to horizontal so that they rest against the edge of the existing RAM chip when placed piggy-back over it. Bend pin 20 (CS-) and pin 22 (OE-) up to horizontal. With the SRAM chip piggy-back over the existing RAM chip bend the very ends of all remaining pins over the edge of the RAM chip to touch it's pins.

Install the second chip directly on top of the first. All but pin 20(CS-) and 22(OE-) are to be soldered to matching pins on the existing RAM chip.

- Jumper U4 pin 3 to U2(Top) pins 20 & 22 (CS- & OE-).

9. FlashROM Socketed Dev Cart

NOTE:- The EEPROM dev cart detailed in earlier versions of this document has been redesigned to accept FlashROM (PEROM). FlashROM has been found to work more reliably with the 7800 dev system.

The 7800 development system can be used to program Flash Programmable and Erasable Read Only Memory (FlashROM or PEROM). The FlashROM chip chosen must be suitable for 5V operation. eg. An Atmel AT29C256-90PI has been used successfully.

This dev cart has been wired for FlashROM pin assignments which differ slightly from regular EPROM or SRAM pin assignments. See below:-

WE-	1	28	Vcc
A12	2	27	A14
A7	3	26	A13
A6	4	25	A8
A5	5	24	A9
A4	6	23	A11
A3	7	22	OE-
A2	8	21	A10
A1	9	20	CS-
A0	10	19	D7
D0	11	18	D6
D1	12	17	D5
D2	13	16	D4
Gnd	14	15	D3

FlashROM pin assignments

FEATURES:-

- 1) The FlashROM is mounted in U1 allowing access while the cartridge is inserted in the console.
- 2) A large area around U1 has been made clear to allow installation of a Zero Insertion Force (ZIF) socket if required. (Maximum foot print is approximately 26mm x 58mm).
- 3) Uploading to the FlashROM dev cart requires use of the -c3 switch. This enables 64K page writes which are required for the Atmel chip.

MODIFYING THE GAME CARTRIDGE:-

- 1) Remove all chips U1 through U5.
- 2) Ensure that jumpers W2,W4 and W6 are open.
- 3) Ensure that jumpers W1,W3 and W5 are bridged.
- 4) Ensure that R2 and C1 are fitted. Use a zero Ohm link or wire jumper at R2.

Remove all other Resistors and capacitors.

- 5) Install your 28-pin Dual In line socket at U1.
- 6) Take a 74LS00 logic chip, bend pins 8 and 9 up to horizontal then install at U4.
- 7) Bridge U4 pin 4 to 5 and pin 9 to 10.
- 8) Jumper U4 pin 6(A15-) to U3 hole 13(CS-).
- 9) Jumper U4 pin 8(R/W-) to U4 pin 13 and U5 hole 6(OE-).
- 10) Jumper U4 pin 11 to U5 hole 5(WE-).

10. 144K Bankswitching Dev Cart

This development cartridge supports all Atari 7800 games except those relying on the bankswitching methods of Absolute or Activision. (eg. Double Dragon, F-18 Hornet and Rampage). Atari's "Pokey" chip functions are not supported, so games such as Ballblazer and Commando lack full sound.

64K games that use bank numbers 0-3 will require the use of the -d switch for uploading. (eg. Tank Command & Pitfighter). Super Huey UH-IX also requires use of the -d switch.

Any cartridge with PCB No.C300565-XXX can be modified, however, using a Summer or Winter games cart or a Crossbow cart will give you a head start since many of the required components are already present.

DESIGN:-

- 1) Atari's bankswitching hardware is used to upload binary files in banks of 16K. Chip enable logic for U1 (main SRAM) and output enable logic for U5 (bankswitching chip) have been modified to allow write access for uploading (through \$C000-\$FFFF).
- 2) This cart can be built using a single 128k x 8 SRAM in U1 or by substituting two 64k x 8 SRAMs or four 32k x 8 SRAMs with chip enable logic controlled by the higher bankswitched address line(s).

MODIFYING THE GAME CARTRIDGE:-

- 1) Remove U1.
- 2) If there is a ROM chip or an 8K RAM chip in U2 then remove it. If there is a 16K or 32K RAM chip in U2 (ie. Summer or Winter Games) and you plan on using a 128K or two 64K SRAMs in U1 then the RAM chip can be used as-is with no difficulty.
- 3) Suck the solder out of all unoccupied component holes except U1 and U2 (not necessary).
- 4) Ensure that jumpers W1,W2,W4,W5 and W6 are open.
- 5) Ensure that jumper W3 is bridged.
- 6) Ensure that R1 and R2 are fitted. (Use zero Ohm links or wire jumpers).
- 7) Ensure that 3.3K Ω resistors are fitted at R3, R4 and R5.
- 8) This modification requires a 74LS02 logic chip at U3 and a 74LS00 logic chip at U4. Fit as required.
- 9) Install C1,C2,C3,C4 & C5 on the back of the PCB. If you plan on using four 32K SRAMs in place of U1 then C1 & C2 can be left on the front of the PCB.
- 10) Take a 74LS20 logic chip, bend pins 5,6,8,10 and 13 up to horizontal then install on top of U3(74LS02).
- 11) Bridge U3(Top) pin 9 to 10 and pin 12 to 13.
- 12) If U5 is not present then take a 74LS374 logic chip and bend pin 1 up to horizontal. Install at U5.

If U5 is present (74LS374) then cut through the PCB trace leading from pin 1. To check that the pin is disconnected test continuity between U5 pin 1 and U2 hole 1.

- 13) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U2. Install at U2.
- 14) Take a 74LS00 logic chip, bend pins 1,3,4,6,8,10,11 and 12 up to horizontal then install on top of U4 (also 74LS00).
- 15) Bridge U4(Top) pin 1 to 2 and pin 10 to 11.
- 16) Jumper U4(Top) pin 3 to U4(Top) pin 12.
- 17) Jumper U4(Top) pin 4 to U3(Top) pin 8.
- 18) Jumper U4(Top) pin 6 to U5(74LS374) pin 1 (OE-)

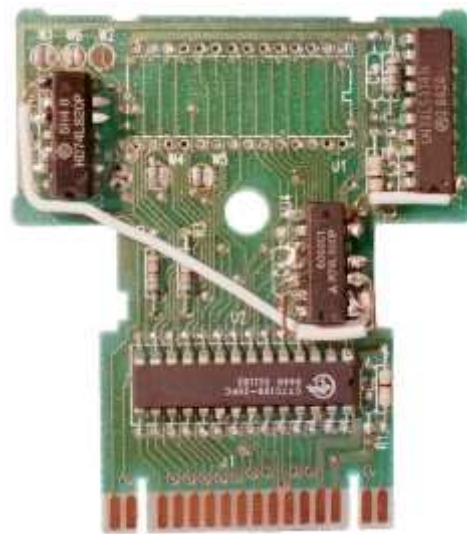


Figure 2 144K BS Dev Cart after Step #18

Follow remaining instructions for the SRAMs you have chosen:-

USING ONE 128Kx8 SRAM

- 19) Take a 32 pin, 128K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U1. Bend pins 1(NC), 2(A16), 22(CS-), 24(OE-), 29(WE-) and 31(A14) up to horizontal. Bend pin 32(Vcc) so that it sits neatly against bare metal on R2.

Install at U1 with pin 3 in hole 1. Solder all mating pins including pin 32(Vcc) to R2.

- 20) Jumper U1 pin 31(A14) to U1 hole 27(A14-BS).
- 21) Jumper U1 pin 2(A16) to U1 hole 22(A16-BS).
- 22) Jumper U1 pin 29(WE-) to U3 pin 2.
- 23) Jumper U4(Top) pin 8 to U1 pins 22 & 24 (CS- & OE-).

USING TWO 64Kx8 SRAMs

- 19) Take a 74LS139 logic chip, bend pins 1,4,5,6,7 and 9 to 15 up to horizontal then install on top of U5(74LS374) with pin 1 over hole 1.
- 20) Jumper U4(Top) pin 8 to U5(Top) pin 15(OE-).

- 21) Take a 32 pin, 64K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U1. Bend pins 1(NC), 2(NC), 22(CS-), 24(OE-), 29(WE-) and 31(A14) up to horizontal. Bend pin 32(Vcc) so that it sits neatly against bare metal on R2.

Install at U1 with pin 3 in hole 1. Solder all mating pins including pin 32(Vcc) to R2.

- 22) Take a (second) 32 pin, 64K SRAM chip and bend the very ends (the last 2mm) of all the pins out to approximately 45 deg. This chip is to sit piggy-backed over the first 64K SRAM chip installed at U1 (per step #21).

Bend pins 1(NC), 2(NC), 22(CS-) and 24(OE-) up to horizontal. Bend pins 29(WE-), 31(A14) and 32(Vcc) so that they fit neatly against matching pins on the first SRAM chip when the two chips are placed together.

Install the second chip directly on top of the first. All but pins 1(NC) 2(NC), 22(CS-) and 24(OE-) are to be soldered to matching pins on the first chip.

- 23) Jumper U1(Top & Bottom) pin 31 to U1 hole 27(A14-BS).
- 24) Jumper U1 hole 22(A16-BS) to U5(Top) pins 13 & 14.
- 25) Jumper U1(Top & Bottom) pin 29(WE-) to U3 pin 2.
- 26) Jumper U5(Top) pin 12 to U1(Bottom) pins 22 & 24 (CS- & OE-).
- 27) Jumper U5(Top) pin 9 to U1(Top) pins 22 & 24 (CS- & OE-).



Figure 3 Completed Dev Cart using two 64Kx8 SRAMs

USING FOUR 32Kx8 SRAMs

Install a 74LS139 logic chip per steps #19 & #20 for the two 64K SRAM mod detailed previously, then:-

- 21) Jumper U5(Top) pin 13 to U1 hole 27(A14-BS).
- 22) Jumper U5(Top) pin 14 to U1 hole 22(A16-BS).
- 23) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg. Bend the narrow part of all but pins 20(CS-), 22(OE-) & 27(WE-) up an additional 90 deg so that pin ends match hole positions of U1 when the chip is placed upside down on the PCB.

Install the chip on the back of the PCB behind the location reserved for U1 with the top of the chip facing the PCB.

- 24) Jumper U1(Back) pin 27(WE-) to U3 pin 2(WE-) on the back of the PCB.
- 25) Take a 28 pin, 32K SRAM chip and bend the very ends (the last 2mm) of all the pins out to approximately 45 deg. This chip is to sit piggy-backed over the 32K SRAM chip previously installed at U2 (per step #13).

Bend pins 1(A14), 20(CS-) and 22(OE-) up to horizontal.

Install the second chip directly on top of the first chip installed at U2. All but pins 1(A14), 20(CS-) and 22(OE-) are to be soldered to matching pins on the first chip.

- 26) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U1. Bend pins 20(CS-), 22(OE-) and 27(WE-) up to horizontal then install at U1.

- 27) Take a 28 pin, 32K SRAM chip and bend the very ends (the last 2mm) of all the pins out to approximately 45 deg. This chip is to sit piggy-backed over the first 32K SRAM chip installed at U1 (per step #26).

Bend pins 20(CS-), and 22(OE-) up to horizontal. Bend pin 27(WE-) so that it meets the matching pin on the first sram chip when the two chips are placed together.

Install the second chip directly on top of the first. All but pins 20 (CS-) and 22 (OE-) are to be soldered to matching pins on the first chip.

- 28) Jumper U1(Top & Bottom) pin 27 (WE-) to U3 pin 2.
- 29) Jumper U2(Top) pin 1 to U1(Top & Bottom) pin 1 (A15-BS).
- 30) Jumper U5(Top) pin 12 to U1(Bottom) pins 20 & 22 (CS- & OE-).
- 31) Jumper U5(Top) pin 11 to U1(Top) pins 20 & 22 (CS- & OE-).
- 32) Jumper U5(Top) pin 10 to U1(Back) pins 20 & 22 (CS- & OE-).
- 33) Jumper U5(Top) pin 9 to U2(Top) pins 20 & 22 (CS- & OE-).

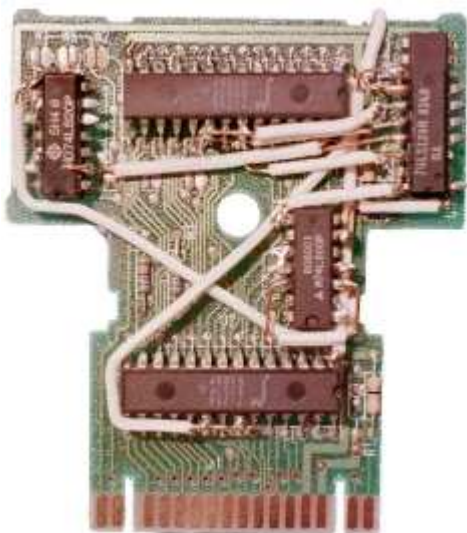


Figure 4 Using four 32Kx8 SRAMs:- *Front*

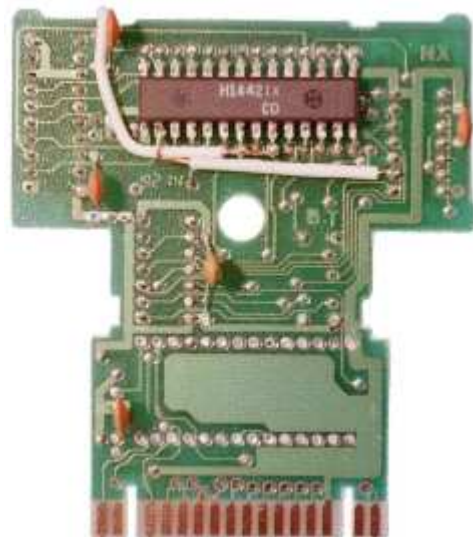


Figure 5 Using four 32Kx8 SRAMs:- *Back*

11. 64K/144K Bankswitching Dev Cart with Built-in BIOS

This development cartridge offers the same Atari 7800 game support as the regular 144K bankswitching dev cart with the added feature of having built-in BIOS routines. This allows the use of an unmodified Atari 7800 console for uploading games.

Any cartridge with PCB No.C300565-XXX or C100339 can be modified, however, the less components there are to begin with the better so it's easiest to start with a 32K or 48K game cartridge.

DESIGN:-

- 1) A flip-flop has been added to control chip selection between EPROM (BIOS) and SRAM (uploaded game). This is done by storing the value of data line D7 which is set whenever a bank number is selected (ie. written in \$8000-\$BFFF).
- 2) At power-up, the "D7" flip-flop clock signal and

data input are initially held low by high value resistors connected to ground. As the clock signal is driven high the flip-flop is automatically set for EPROM (BIOS) selection.

- 3) Uploading of files is accomplished using the same means as the regular 144K bankswitching dev cart.
- 4) This cart can be built using a single 128k x 8 SRAM in U2 or by substituting two 64k x 8 SRAMs or two 32k x 8 SRAMs with chip enable logic controlled by the bankswitched line for A15.
- 5) Using two 32K x 8 SRAMS results in a 64K version of the cart which still provides at least partial support for a few 128K games:-
 - Karateka and Waterski play fine.
 - Barnyard Blaster, Jinks & Sentinel play with dodgy graphics.
 - Fatal Run allows you to drive through the first level.

11.1 Modifying Game Cartridge PCB Type C300565-XXX

- 1) Remove all chips U1 through U5.
- 2) Suck the solder out of all unoccupied component holes.
- 3) Ensure that jumpers W2 & W5 are bridged. All other jumpers are to be open.
- 4) Ensure that R1 and R2 are fitted. (Use zero Ohm links or wire jumpers).
- 5) Remove R3,R4 and R5 if present.
- 6) Ensure that C1 through C5 are fitted. (C2, C3 & C4 need to be on the back of the PCB).
- 7) Take a 74LS02 logic chip, bend pins 11 and 13 up to horizontal then install at U3.
- 8) Jumper U3(LS02) pin 9 (R/W) to pin 11.
- 9) Take a 74LS32 logic chip, bend pins 1,2,3,5,6 and 8 to 12 up to horizontal. Bend the narrow part of pin 13 so that it fits neatly against the matching pin on U3(LS02) when the two are placed together.

Install on top of U3(LS02). Solder pin 13 and all remaining vertical pins to matching pins on the bottom chip.

- 10) Jumper U3(Top) pin 6 to U4 hole 8.
- 11) Take a 74LS00 logic chip, bend pins 8 & 10 up to horizontal then install at U4.
- 12) Jumper U4(LS00) pin 8 to U3(Top) pin 12.
- 13) Take a 74LS374 logic chip, bend pins 1,2,5 & 6 up to horizontal then install at U5.
- 14) Using a 3.3K Ω resistor, jumper U5(LS374) pin 5 to the bottom hole reserved for C5 (+5V) on the back of the PCB. (This hole is connected to R2 by a wide trace on the back of the PCB).
- 15) Take a (second) 74LS374 logic chip, bend pins 1,2,5 6,9,12,15,16,17 & 19 up to horizontal then install on top of U5(also LS374).

- 16) Install a zero Ohm link or wire jumper at R4.
- 17) Using a 3.3K Ω resistor, jumper U5(Top) pin 1 to pin 17.
- 18) Jumper U5(Top) pin 1 to pin 8(Gnd).
- 19) Using a 3.3K Ω resistor, jumper U5 pin 10(Gnd) to pin 11 (Clk) on the back of the PCB.
- 20) Jumper U5(Top) pin 16 to U4(Bottom) pin 10 and U3(Top) pin 5. (Stored value of D7-).
- 21) Take a 74LS02 logic chip, bend pins 1,3,4,5,6 and 8 to 13 up to horizontal then install on top of U4(LS00).
- 22) Bridge U4(Top) pin 2 (A14) to pin 3.
- 23) Jumper U4(Top) pin 1 (A14-) to pin 5.
- 24) Jumper U4(Top) pin 4 to U5(Bottom) pin 1 (OE-).
- 25) Jumper U4(Top) pin 6 to U4(Bottom) pin 13 (R/W-), on the back of the PCB.
- 26) Jumper U4(Top) pin 10 (D7-) to U5(Top) pin 17.
- 27) Take a 28 pin D.I.L. socket and install at U1. (Install the Ramona BIOS chip in this socket after completing the dev cart. An 8K, 16K or 32K EPROM can be used with the Ramona BIOS copied to the highest possible address in the ROM space).
- 28) Jumper U1 pin 19 (D7) from the back of the PCB to U4(Top) pins 8 & 9.
- 29) Jumper U1 pin 22 (OE-) to U3(Bottom) pin 10 (R/W-) on the back of the PCB.

All supporting circuitry for the Ramona BIOS is now installed. Test your work by fitting the BIOS chip in U1. Try the dev cart in an unmodified 7800 console. The Ramona cart menu should display.

30) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg. Bend the narrow part of all pins up an additional 90 deg so that pin ends match hole positions of U2 when the chip is placed upside down on the PCB.

Install on the back of the PCB behind the location reserved for U2 with the top of the chip facing the PCB. Tack in place only. Complete soldering when installing the main SRAM at U2.

Follow remaining instructions for the SRAMs you have chosen:-

USING ONE 128Kx8 SRAM

31) Take a 32 pin, 128K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U2. Bend pins 1(NC), 2(A16), 3(A14), 22(CS-), 24(OE-) and 31(A15) up to horizontal. Bend pin 32(Vcc) so that it sits neatly against bare metal on R1.

Install at U2 with pin 3 in hole 1. Solder all mating pins including pin 32 (Vcc) to R1. Finish soldering the 32K SRAM on the back of U2 (Step #30).

- 32) Using a 3.3K Ω resistor, jumper U2 pin 3 to the bottom hole reserved for R3 (+5V).
- 33) Using a 3.3K Ω resistor, jumper U2 pin 2 to the bottom hole reserved for R5 (+5V).
- 34) Jumper U3(Top) pin 11 to U2 pins 22 & 24 (CS- & OE-).
- 35) Jumper U5(Bottom) pin 2 (A14-BS) to U2 pin 3.
- 36) Jumper U5(Bottom) pin 5 (A15-BS) to U2 pin 31.
- 37) Jumper U5(Bottom) pin 6 (A16-BS) to U2 pin 2.

USING TWO 64Kx8 SRAMs

- 31) Jumper U4(Top) pins 11 & 12 to U3(Top) pin 2 and U5(Bottom) pin 5 (A15-BS).
- 32) Jumper U4(Top) pin 13 to U3(Top) pin 9.
- 33) Jumper U3(Top) pin 1 to pins 10 & 11.

34) Take a 32 pin, 64K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U2. Bend pins 1(NC), 2(NC), 3(A14), 22(CS-), 24(OE-) and 31(A15) up to horizontal. Bend pin 32(Vcc) so that it sits neatly against bare metal on R1.

Install at U2 with pin 3 in hole 1. Solder all mating pins including pin 32 (Vcc) to R1. Finish soldering the 32K SRAM on the back of U2 (Step #30).

35) Take a (second) 32 pin, 64K SRAM chip and bend the very ends (the last 2mm) of all the pins out to approximately 45 deg. This chip is to sit piggy-backed over the first 64K SRAM chip installed at U2 (per step #34).

Bend pins 1(NC), 2(NC), 22(CS-) and 24(OE-) up to horizontal. Bend pins 3(A14), 31(A15) and 32(Vcc) so that they fit neatly against matching pins on the first SRAM chip when the two chips are placed together.

Install the second chip directly on top of the first. All but pins 1(NC) 2(NC), 22(CS-) and 24(OE-) are to be soldered to matching pins on the first chip.

- 36) Using a 3.3K Ω resistor, jumper U2(Top & Bottom) pin 3 to the bottom hole reserved for R3 (+5V).
- 37) Using a 3.3K Ω resistor, jumper U2(Top & Bottom) pin 31 to U2 pin 28(+5V).
- 38) Jumper U2(top & Bottom) pin 3 to U5(Bottom) pin 2 (A14-BS).
- 39) Jumper U2(Top & Bottom) pin 31 to U5(Bottom) pin 6 (A16-BS).
- 40) Jumper U3(Top) pin 3 to U2(Bottom) pins 22 & 24 (CS- & OE-).
- 41) Jumper U3(Top) pin 8 to U2(Top) pins 22 & 24 (CS- & OE-).

USING TWO 32Kx8 SRAMs (64K VERSION OF CART)

Install all jumpers per steps #31 through #33 for the two 64K SRAM mod detailed previously, then:-

- 34) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U2. Bend pins 1(A14), 20(CS-) and 22(OE-) up to horizontal then install at U2. Finish soldering the 32K SRAM on the back of U2 (Step #30).
- 35) Take a 28 pin, 32K SRAM chip and bend the very ends (the last 2mm) of all the pins out to approximately 45 deg. This chip is to sit piggy-backed over the first 32K SRAM chip installed at U2 (per step #34).

Bend pins 20(CS-), and 22(OE-) up to horizontal. Bend pin 1(A14) so that it meets the matching pin on the first sram chip when the two chips are placed together.

Install the second chip directly on top of the first. All but pins 20(CS-) and 22(OE-) are to be soldered to matching pins on the first chip.

- 36) Using a 3.3K Ω resistor, jumper U2(Top & Bottom) pin 1 to the bottom hole reserved for R3 (+5V).
- 37) Jumper U2(Top & Bottom) pin 1 to U5(Bottom) pin 2 (A14-BS).
- 38) Jumper U3(Top) pin 3 to U2(Bottom) pins 20 & 22 (CS- & OE-).
- 39) Jumper U3(Top) pin 8 to U2(Top) pins 20 & 22 (CS- & OE-).

11.2 Modifying Game Cartridge PCB Type C100339

- 1) Remove all chips U1 through U5.
- 2) Suck the solder out of all unoccupied component holes.
- 3) Ensure that jumpers W7 & W8 are bridged. All other jumpers are to be open.
- 4) Locate the trace leading to U4 hole 27 on the top of the PCB. Cut or drill the trace through next to hole 27.
- 5) Remove all resistors R1 through R5 where present.
- 6) Ensure that C1 through C5 are fitted. (Install C4 on the back of the PCB).
- 7) Take a 74LS10 logic chip, bend pins 3 and 8 up to horizontal then install at U3.
- 8) Bridge U3(10) pins 3 to 4 to 5.
- 9) Jumper U3(10) pin 6 (R/W-) to the right-hand hole reserved for R1.
- 10) Jumper U3(10) pin 6 (R/W-) to pin 9 on the back of the PCB.
- 11) Take a 74LS32 logic chip, bend pins 1 to 6 and 8 to 12 up to horizontal then install on top of U3(10).
- 12) Jumper U3(10) pin 6 to U2 hole 10.
- 13) Take a 74LS02 logic chip, bend pins 4,5,9 & 10 up to horizontal then install at U2.
- 14) Bridge U2(10) pin 8 to pin 9.
- 15) Jumper U2(10) pin 5 to U2 hole 4 on the back of the PCB.
- 16) Jumper U2(10) pin 10 to U3(10) pin 4.
- 17) Take a 74LS374 logic chip, bend pins 1,15,16 & 19 up to horizontal then install at U5.
- 18) Install a zero Ohm link or wire jumper at R5 on the back of the PCB.
- 19) Jumper U2(10) pin 4 to U5(10) pin 1 (OE-).
- 20) Take a 74LS174 logic chip, bend pins 1,2,3,5,7,10,12,15 & 16 up to horizontal. This chip is to be installed on top of U5(10) with pin 1 over hole 3. Bend the narrow part of pins 13 & 14 so that they fit neatly against mating pins on U5(10) when the two are placed together.

Install on top of U5(10) with pin 1 over hole 3. Solder pins 13,14 and all remaining vertical pins to mating pins on the bottom chip.

- 21) Using a 3.3K Ω resistor, jumper U5(10) pin 14 to the bottom hole reserved for R4 (+5V). Be sure to leave space for the main SRAM that is to be installed at U4.
- 22) Using a 3.3K Ω resistor, jumper U5(10) pin 3 to pin 8.
- 23) Using a 3.3K Ω resistor, jumper U5(10) pin 10(Gnd) to pin 11(Clk) on the back of the PCB.
- 24) Jumper U5(10) pin 20 (+5V) to U5(10) pins 1 and 16.
- 25) Take a 74LS00 logic chip, bend pins 1,3,4,5,6,8,10, 11,12 & 13 up to horizontal. Bend the narrow part of pin 9 so that it fits neatly against the matching pin on U2(10) when the two are placed together.

Install on top of U2(10). Solder pin 9 and all remaining vertical pins to matching pins on the bottom chip.

- 26) Jumper U5(10) pin 2 to U2(10) pin 10 and U3(10) pin 5. (Stored value of D7-).
- 27) Jumper U2(10) pin 1 to U3(10) pin 4 (A15-). Take care not to disturb the existing jumper at U3(10) pin 4.
- 28) Jumper U2(10) pin 3 to U3 hole 8 on the back of the PCB.
- 29) Jumper U2(10) pin 6 (D7-) to U5(10) pin 3.
- 30) Jumper U2(10) pin 8 to U3(10) pin 12.
- 31) Take a 28 pin D.I.L. socket and install at U1. (Install the Ramona BIOS chip in this socket after completing the dev cart. An 8K, 16K or 32K EPROM can be used with the Ramona BIOS copied to the highest possible address in the ROM space).
- 32) Jumper U1 pin 19 (D7) from the back of the PCB to U2(10) pins 4 & 5.

All supporting circuitry for the Ramona BIOS is now installed. Test your work by fitting the BIOS chip in U1. Try the dev cart in an unmodified 7800 console. The Ramona cart menu should display.

- 33) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg. Bend the narrow part of all pins up an additional 90 deg so that pin ends match hole positions of U4 when the chip is placed upside down on the PCB.

Install on the back of the PCB behind the location reserved for U4 with the top of the chip facing the PCB. Tack in place only. Complete soldering when installing the main SRAM at U4.

Follow remaining instructions for the SRAMs you have chosen:-

USING ONE 128Kx8 SRAM

- 34) Take a 32 pin, 128K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U4. Bend pins 1(NC), 2(A16), 3(A14), 22(CS-), 24(OE-), 31(A15) and 32(Vcc) up to horizontal then install at U4 with pin 3 in hole 1. Finish soldering the 32K SRAM on the back of U4 (Step #33).
- 35) Using a 3.3K Ω resistor, jumper U4 pin 3 to the top hole reserved for R3 (+5V).
- 36) Jumper U4 pin 32(Vcc) to the left-hand hole reserved for R1 (+5V).
- 37) Using a 3.3K Ω resistor, jumper U4 pin 31 to U5(Top) pin 16 (+5V).
- 38) Jumper U3(Top) pin 11 to U4 pins 22 & 24 (CS- & OE-).
- 39) Jumper U5(Top) pin 13 (A14-BS) to U4 pin 3.
- 40) Jumper U5(Top) pin 14 (A15-BS) to U4 pin 2.
- 41) Jumper U5(Bottom) pin 19 (A16-BS) to U4 pin 31.
- 42) Jumper U3(Bottom) pin 8 to U4 hole 27 on the back of the PCB.

USING TWO 64Kx8 SRAMs

- 34) Jumper U2(Top) pins 12 & 13 to U3(Top) pin 2 and U5(Top) pin 14 (A15-BS).
- 35) Jumper U2(Top) pin 11 to U3(Top) pin 9.
- 36) Jumper U3(Top) pin 1 to pins 10 & 11.

- 37) Take a 32 pin, 64K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U4. Bend pins 1(NC), 2(NC), 3(A14), 22(CS-), 24(OE-), 31(A15) and 32(Vcc) up to horizontal then install at U4 with pin 3 in hole 1. Finish soldering the 32K SRAM on the back of U4 (Step #33).
- 38) Take a (second) 32 pin, 64K SRAM chip and bend the very ends (the last 2mm) of all the pins out to approximately 45 deg. This chip is to sit piggy-backed over the first 64K SRAM chip installed at U4 (per step #37).

Bend pins 1(NC), 2(NC), 22(CS-) and 24(OE-) up to horizontal. Bend pins 3(A14), 31(A15) and 32(Vcc) so that they fit neatly against matching pins on the first SRAM chip when the two are placed together.

Install the second chip directly on top of the first. All but pins 1(NC) 2(NC), 22(CS-) and 24(OE-) are to be soldered to matching pins on the first chip.

- 39) Using a 3.3K Ω resistor, jumper U4(Top & Bottom) pin 3 to the top hole reserved for R3 (+5V).
- 40) Jumper U4(Top & Bottom) pin 32 to the left-hand hole reserved for R1 (+5V).
- 41) Using a 3.3K Ω resistor, jumper U4(Top & Bottom) pin 31 to U5(Top) pin 16 (+5V).
- 42) Jumper U4(Top & Bottom) pin 3 to U5(Top) pin 13 (A14-BS).
- 43) Jumper U4(Top & Bottom) pin 31 to U5(Bottom) pin 19 (A16-BS).
- 44) Jumper U3(Top) pin 3 to U4(Bottom) pins 22 & 24 (CS- & OE-).
- 45) Jumper U3(Top) pin 8 to U4(Top) pins 22 & 24 (CS- & OE-).
- 46) Jumper U3(Bottom) pin 8 to U4 hole 27 on the back of the PCB.

USING TWO 32Kx8 SRAMs (64K VERSION OF CART)

Install all jumpers per steps #34 through #36 for the two 64K SRAM mod detailed previously, then:-

- 37) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U4. Bend pins 1(A14), 20(CS-) and 22(OE-) up to horizontal then install at U4. Finish soldering the 32K SRAM on the back of U4 (Step #33).
- 38) Take a 28 pin, 32K SRAM chip and bend the very ends (the last 2mm) of all the pins out to approximately 45 deg. This chip is to sit piggy-backed over the first 32K SRAM chip installed at U4 (per step #37). Bend pins 20(CS-), and 22(OE-) up to horizontal. Bend pin 1(A14) so that it meets the matching pin on the first sram chip when the two chips are placed together.

Install the second chip directly on top of the first. All but pins 20(CS-) and 22(OE-) are to be soldered to matching pins on the first chip.

- 39) Using a 3.3K Ω resistor, jumper U4(Top & Bottom) pin 1 to the top hole reserved for R3 (+5V).
- 40) Jumper U4(Top & Bottom) pin 1 to U5(Top) pin 13 (A14-BS).
- 41) Jumper U3(Top) pin 3 to U4(Bottom) pins 20 & 22 (CS- & OE-).
- 42) Jumper U3(Top) pin 8 to U4(Top) pins 20 & 22 (CS- & OE-).
- 43) Jumper U3(Bottom) pin 8 to U4 hole 27 on the back of the PCB.

12. Combined 2K/4K & 8K/F8 Bankswitching Dev Cart

This development cartridge supports 2K & 4K linear games plus 8K 2600 games which use the F8 bankswitching method. This method uses access to one of two ROM address hot spots to trigger bank selection. Hot spots are at \$1FF8 and \$1FF9.

Use a C300565-XXX PCB for this mod.

FEATURES:-

- 1) Supported games can be uploaded normally with bankswitching turned "off". (For 8K/F8 games switch bankswitching "on" after uploading). Otherwise, 8K/F8 games can be uploaded with bankswitching "on" by using the -f switch.
- 2) Bank number is stored in an LS374 flip-flop. Both the flip-flop trigger signal and SRAM enable signals are gated with the system's phase 2 clock signal to aid 2600 compatibility.
- 3) Flip-flop output is enabled for read only. This allows automatic selection between A12(Edge) and A12-BS for upload and play respectively.

MODIFYING THE GAME CARTRIDGE:-

- 1) Remove all chips U1 through U5.
- 2) Suck the solder out of all unoccupied component holes except U1 and U2 (not necessary).
- 3) Ensure that jumpers W1 and W3 are bridged. All other jumpers are to be open.
- 4) Ensure that R1 and R2 are fitted. (Use zero Ohm links or wire jumpers).
- 5) Ensure that 3.3K Ω resistors are fitted at R3, R4 and R5.
- 6) Install C1 through C5. (Fit C3 and C4 on the back).
- 7) Take a 74LS30 logic chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U1. Bend pins 1,2,7,8 and 12 up to horizontal.

Install at U1 with pin 1 over hole 1.

- 8) Jumper U1 pin1 to pin 10(A9).
- 9) Jumper U1 pin 2 to pin 9(A11).
- 10) Jumper U1 pin 7 to U1 hole 14(Gnd).
- 11) Jumper U1 pin 12 to U1 hole 21(A10).
- 12) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U2. Bend pins 1(A14), 2(A12), 20(CS-), 22(OE-) and 26(A13) up to horizontal.

If you are making a dev cart with Super Chip RAM (Sections 13 or 14) then bend pin 3(A7) up to horizontal.

Install at U2.

- 13) Take a 74LS32 logic chip, bend pins 1,2,3,6,8,10,11 & 12 up to horizontal then install at U3.
- 14) Jumper U3 pin 6 to U3 hole 10 on the back of the PCB.
- 15) Jumper U2 hole 2(A12) to U4 hole 1 on the back of the PCB.
- 16) Take a 74LS00 logic chip, bend pins 1,2,3,4,5,6,8,9 and 11 up to horizontal then install at U4.
- 17) Jumper U4 pin 4 to U1 hole 1(A12-BS).
- 18) Jumper U4 pin 5 to U1 hole 2(A12).
- 19) Jumper U4 pin 6 to U2 pin 2(A12).
- 20) Take a 74LS374 logic chip, bend pins 1,3,4,7 and 11 up to horizontal then install at U5.
- 21) Jumper U5 pin 4 to U1 hole 10(A0).
- 22) Take a 74LS138 logic chip and bend pins 1,2,4,5,6,7 and 9 through 15 up to horizontal. This chip is to be installed on top of U5(LS374) with pin 1 over hole 1. Bend the narrow part of pin 3 so that it fits neatly against the matching pin on U5(LS374) when the two are placed together.

Install on top of U5(LS374). Solder pin 3 and all remaining vertical pins to matching pins on the bottom chip.

- 23) Jumper U5(Top) pin 6 to U1 pin 14(+5V).
- 24) Jumper U5(Top) pin 2 to U2 pin 8(A2).
- 25) Jumper U5(Top & Bottom) pin 3 to U2 pin 7(A3).
- 26) Jumper U5(Top) pin 4 to U1 pin 8.
- 27) Jumper U4 pin 11 to U2 pins 20 & 22 (CS- & OE-) and to U5(Top) pin 5.
- 28) Take a miniature, single pole, dual toggle (SPDT) switch and fit it in the front of the cartridge case. A slide switch is preferred. Probably the best location for the switch is at either side of the PCB approximately 12mm from the side of the case and 44mm from the top end of the case. Remove the switch again until the dev cart mod is finished.

- 29) Jumper the central pole of the SPDT switch to U5(Bottom) pin 1.
- 30) Jumper one switching pole of the SPDT switch to the bottom hole reserved for C5(+5V). This hole is connected to R2 by a wide trace on the back of the PCB (this is the bankswitching "Off" position for 2K & 4K games).
- 31) Jumper the remaining switching pole of the SPDT switch to U4 pin 8. (This is the bankswitching "On" position for 8K/F8 games).
- 32) Jumper U2 pin 9(A1) to U5(Top) pin 1.
- 33) Bridge U5(Bottom) pin 7 to pin 8(Gnd).
- 34) Jumper U2 pin 28(+5V) to pin 1(A14) and pin 26(A13).
- 35) Jumper U5(Top) pin 11 to U5(Bottom) pin 11(Clk).
- 36) Bridge U4 pin 9 to pin 10.
- 37) Jumper U4 pin 10(R/W) to hole 11 (on the back of the PCB).

TROUBLESHOOTING:-

- Upload a file without the -f switch and 7800ctrl will read back and check every byte uploaded to the SRAM. This can be used to see if the cart is uploading to the SRAM.
- Also, "Test Pattern" (color bar generator) by Video Soft should upload and play perfectly with bank-switching "on" or "off" (Use 7800ctrl -f filename.bin). This also indicates if uploaded files are being written to the SRAM.

13. Combined 8K/F8 & 16K/F6 Bankswitching Dev Cart with SC RAM

This development cartridge supports 8K and 16K 2600 games which use F8 or F6 bankswitching. The required method of bankswitching is selected using a switch. Access to ROM address hot spots is used to trigger bank selection. F8 hot spots are at \$1FF8 and \$1FF9 whilst F6 hot spots are at \$1FF6 through \$1FF9.

For upload, the -f switch is required (needs DevOS V 0.2).

Features are similar to the 8K/F8 dev cart with the addition of Super Chip RAM support that can be enabled using a switch. The following games require Super Chip RAM:-

	Crystal Castles		Off The Wall
*	Dark Chambers		Radar Lock
	Desert Falcon		Save Mary!
	Dig Dug		Secret Quest
	Elevator Action		Shooting Arcade
	Jnr Pacman		Sprintmaster
	Klax	*	Stargate (Defender II)
	Millipede		Super Football

Table 7

* Not supported

Use a C300565-XXX PCB for this mod.

MODIFYING THE GAME CARTRIDGE:-

Complete all steps #1 through #28 for the 8K/F8 Dev Cart detailed in Section 12, then:-

29)Take a 74LS08 logic chip, bend pins 1,2,3,4,5,6,8,10 & 11 up to horizontal. Bend the narrow part of pin 12 so that it fits neatly against the matching pin on U3(LS32) when the two are placed together.

Install on top of U3(LS32). Solder pin 12 and all remaining vertical pins to matching pins on the bottom chip.

- 30)Jumper U3(Top) pin 8 to U2 pin 27(WE-).
- 31)Jumper U3(Top) pin 10 to U3(Bottom) pin 11.
- 32)Jumper U3(Top & Bottom) pin 13 to U4(LS00) pin 9.
- 33)Jumper U3(Top & Bottom) pin 12 to U1 pin 3(A7).
- 34)Jumper U3(Top) pin 11 to U2 pin 3(A7).
- 35)Take a 74LS32 logic chip, bend pins 1,2,3,4,5,6,8,9, 11,12 & 13 up to horizontal then install on top of U4(LS00).
- 36)Bridge U4(Top) pin 3 to pin 4.
- 37)Jumper U4(Top) pin 1 to U2 pin 25(A8).
- 38)Jumper U4(Top) pin 2 to U2 pin 24(A9).

- 39)Jumper U4(Top) pin 12 to U2 pin 21(A10).
- 40)Jumper U4(Top) pin 13 to U2 pin 23(A11).
- 41)Jumper U4(Top) pin 5 to pin 11.
- 42)Jumper the central pole of the SPDT switch to U1 hole 20.
- 43)Jumper one switching pole of the SPDT switch to U4(Top) pin 6. (This is the Super Chip RAM "On" position).
- 44)Jumper the remaining switching pole of the SPDT switch to the bottom hole reserved for C5 (+5V). (This is the Super Chip RAM "Off" position).
- 45)Jumper U3(Top) pin 3 to U2 pin 26(A13).
- 46)Jumper U3(Top) pin 5 to U5(Top) pin 11(y4).
- 47)Jumper U3(Top) pin 6 to U5(Bottom) pin 11(Clk).
- 48)Take a (second) miniature SPDT switch and fit it in the front of the cartridge case. Locate to the side of the PCB opposite the switch installed per Step #28. Remove the switch again until the dev cart mod is finished.

-
- 49)Jumper the central pole of the SPDT switch to U3(Top) pin 4.
 - 50)Jumper one switching pole of the SPDT switch to U5(Top) pin 12(y3). (This is the "16K/F6" position).
 - 51)Jumper the remaining switching pole of the SPDT switch to the bottom hole reserved for C5 (+5V). (This is the "8K/F8" position).
 - 52)Jumper U5(Bottom) pin1(OE-) to U4(Bottom) pin 8.
 - 53)Jumper U3(Bottom) pin 1 to U4(Top) pin 8.
 - 54)Jumper U3(Bottom) pin 2 to U2 hole 26(A13).
 - 55)Jumper U3(Bottom) pin 3 to U3(Top) pin 1.
 - 56)Jumper U3(Top) pin 2 to U1 pin 13(A13-BS).
 - 57)Jumper U3(Top & Bottom) pin 13 to U4(Bottom) pins 1 & 2. (Do not disturb the existing jumper attached to pin 13).
 - 58)Jumper U4(Bottom) pin 3 to U4(Top) pin 9.
 - 59)Jumper U2 pin 28(+5V) to pin 1(A14).
 - 60)Jumper U2 pin 9(A1) to U5(Top) pin 1.
 - 61)Bridge U5(Bottom) pin 7 to pin 8.

TROUBLESHOOTING:-

- ◆ The upload/play logic of this cart prevents uploading without the -f switch, however, "Test Pattern" (color bar generator) by Video Soft should upload and play for both 8K/F8 and 16K/F6 settings. Super Chip RAM must be disabled and the program should work whether cartridge bankswitching is functioning or not. (Use 7800ctrl -f filename.bin).

OPTIONAL 2K/4K SUPPORT:-

- 62) Take a (third) miniature SPDT switch and fit somewhere on the case. (I'm leaving this one to the reader).
- 63) Remove the jumper from U5(Bottom) pin 1 to U4(Bottom) pin 8.
- 64) Jumper the central pole of the SPDT switch to U5(Bottom) pin 1.
- 65) Jumper one switching pole of the SPDT switch to

the bottom hole reserved for C5(+5V). This hole is connected to R2 by a wide trace on the back of the PCB.

(This is the bankswitching "Off" position for 2K & 4K games).

- 66) Jumper the remaining switching pole of the SPDT switch to U4(Bottom) pin 8. (This is the bankswitching "On" position for 8K/F8 and 16K/F6 games).

14. Combined 2K/4K & 32K/F4 Bankswitching Dev Cart with SC RAM

This development cartridge supports 2K & 4K linear games plus 32K 2600 games which use the F4 bankswitching method. This method uses access to one of eight ROM address hot spots to trigger bank selection. Hot spots are at \$1FF4 through \$1FFB.

Features are similar to the 8K/F8 dev cart with the addition of Super Chip RAM support that can be enabled using a switch. Because there are so few 32K/F4 games for the Atari 2600 this dev cart will be most useful to a developer who specifically wants to test a 32K VCS program. Marble Craze by Paul Slocum and Fatal Run are supported. (Fatal Run requires SC RAM).

Development of a 2K or 4K game using Super Chip RAM is also possible! Any takers?

For upload, this cartridge must be treated as a linear type and the -f switch is required (needs DevOS V0.2).

Typical command:-

```
7800ctrl -c1 -f filename.bin
```

Use a C300565-XXX PCB for this mod.

MODIFYING THE GAME CARTRIDGE:-

Complete all steps #1 through #48 for the combined 8K/F8 & 16K/F6 Dev Cart detailed in Section 13, then:-

- 49) Jumper the central pole of the SPDT switch to U5(Bottom) pin 1.
- 50) Jumper one switching pole of the SPDT switch to the bottom hole reserved for C5(+5V). This hole is connected to R2 by a wide trace on the back of the PCB.
(This is the bankswitching "Off" position for 2K & 4K games).
- 51) Jumper the remaining switching pole of the SPDT switch to U4(Bottom) pin 8. (This is the bankswitching "On" position for 32K/F4 games).
- 52) Jumper U3(Bottom) pin 8 to U3(Top) pin 2.
- 53) Jumper U3(Bottom) pin 10 to U1 hole 26(A13).
- 54) Jumper U3(Top) pin 1 to U1 hole 22(A13-BS).
- 55) Jumper U3(Top) pin 4 to U5(Top) pin 12(y3).
- 56) Jumper U4(Bottom) pin 1 to U4(Top) pin 8.
- 57) Jumper U4(Bottom) pin 2 to U1 pin 13(A14-BS).
- 58) Jumper U4(Bottom) pin 3 to U2 pin 1(A14).
- 59) Jumper U4(Top) pin 9 to U2 hole 1(A14).
- 60) Jumper U5(Bottom) pin 7 to U1 hole 9(A1).
- 61) Bridge U5(Top) pin 1 to pin 2.

TROUBLESHOOTING:-

- The upload/play logic of this cart prevents uploading without the -f switch, however, "Test Pattern" (color bar generator) by Video Soft should upload and play perfectly with bankswitching switched on or off. Super Chip RAM must be disabled. (Use 7800ctrl -c1 -f filename.bin).
- Eckhard Stolberg's 32K/F4 test program, f4_test.bin can be used to test bankswitching and Super Chip RAM. The program displays four digits:-
 - The first two digits represent the current bank number ("00" to "07"), which normally begins at bank "07". Cycle through banks using the fire button.
 - The second two digits will mirror the bank number when SC RAM is working, if not then "FF" is displayed.

15. Linear 2K/4K Dev Cart with Built-in BIOS

This development cartridge supports 2K & 4K linear games and has built-in BIOS routines. This allows the use of an unmodified Atari 7800 console for uploading games.

This is the simplest of the available Ramona dev cart designs. The method used for selecting between Ramona BIOS and SRAM is defined in section 11.

No special command line switches are required when uploading using 7800ctrl.exe. (Use the -d switch for 2K games).

Use a C300565-XXX PCB for this mod.

MODIFYING THE GAME CARTRIDGE:-

- 1) Remove all chips U1 through U5.
- 2) Suck the solder out of all unoccupied component holes except U2 (not necessary).
- 3) Ensure that jumpers W2 and W5 are bridged. All other jumpers are to be open.
- 4) Ensure that R1 and R2 are fitted. (Use zero Ohm links or wire jumpers).
- 5) If R3, R4 or R5 are present then remove. Fit a bare wire jumper at R4. Make this a snug fit for better access to U5. (R3 and R5 are to remain open).
- 6) Install C1 through C5. (Fit C2, C3 and C4 on the back of the PCB).
- 7) Take a 74LS02 logic chip, bend pins 2,5,6,12 & 13 up to horizontal then install at U3.
- 8) Take a 74LS00 logic chip, bend pins 2,10 & 11 up to horizontal.

Install at U4.

- 9) Take a 28 pin DIL socket and install at U1.

If you are building a dev cart bigger than 2K/4K (Section 16), then tack in place only. eg. tack pins 14 & 28.

(Install the Ramona BIOS chip in this socket after completing the dev cart. An 8K, 16K or 32K EPROM can be used with the Ramona BIOS copied to the highest possible address in the ROM space).

- 10) Jumper U1 pin 2(A12) on the back of the PCB, to U3 pin 12.
- 11) Jumper U1 pin 22(OE-) to U4 pin 13(R/W-) on the back of the PCB.
- 12) Jumper U3 pin 2 to U4 pin 11.
- 13) Jumper U4 hole 10(R/W) to hole 11 on the back of the PCB.
- 14) Using a 3.3K Ω resistor, jumper U5 hole 8(Gnd) to hole 11(Clk) on the back of the PCB. Make it a snug fit.
- 15) Take a 74LS174 logic chip, bend pins 2,4,5,6,7,9, 10,11,12,15 & 16 up to horizontal then install on the back of U5 with pin 1 in hole 20.

Because this logic chip is fitted directly to the back of the PCB, it's pin numbers are mirrored with respect to U5 hole numbers.

- 16) Bridge U5(Back) pin 3 to 4 and pin 11 to 12.
- 17) Using a 3.3K Ω resistor, jumper U5(Back) pin 6 to the bottom hole reserved for C5(+5V). This hole is connected to R2 by a wide trace on the back of the PCB.
- 18) Jumper U5(Back) pin 6 to U1 pin 19(D7) on the back of the PCB.
- 19) Jumper U5(Back) pin 7 to U4 pin 10(Stored value of D7).
- 20) Jumper U5(Back) pin 9 to U5 hole 11(Clk).
- 21) Jumper U5(Back) pin 16 to the bottom hole reserved for C5(+5V).
- 22) Take a 28 pin, 32K SRAM chip and bend all the pins out to approximately 45 deg so that pin ends match hole positions of U2. Bend pins 1(A14), 2(A12) and 26(A13) up to horizontal.

Install at U2.
- 23) Jumper U3 pin 5 to pin 13.
- 24) Jumper U4 pin 2 to pin 12(Clk 2) on the back of the PCB.
- 25) Jumper U4 pin 10 to U3 pin 6. (Do not disturb jumper already connected to U4 pin 10).

- 26) Jumper U2 pins 1(A14), 2(A12) & 26(A13) to pin 28(+5V).

16. Combined 2K/4K, 8K/F8 & 16K/F6 Bankswitching Dev Cart with Built-in BIOS

This development cartridge supports 2K & 4K linear games, plus 8K and 16K 2600 games which use F8 or F6 bankswitching. Built-in BIOS routines allow use of an unmodified Atari 7800 console.

This is the most complex of the available Ramona dev cart designs and will require the builder's utmost tenacity. This is my personal limit to dev cart design using an existing game PCB.

A switch is used to disable bankswitching for play of linear games. With bankswitching enabled, the required method of bankswitching is selected using a second switch. Access to ROM address hot spots is used to trigger bank selection. F8 hot spots are at \$1FF8 and \$1FF9 whilst F6 hot spots are at \$1FF6 through \$1FF9.

No special command line switches are required when uploading 2K or 4K games. (Use the -d switch for 2K games). For upload of 8K & 16K games, the -f switch is required.

Use a C300565-XXX PCB for this mod.

MODIFYING THE GAME CARTRIDGE:-

Complete all steps #1 through #25 for the 2K/4K Dev Cart detailed in Section 15, then:-

26) Take a 74LS30 logic chip and bend all the pins out to horizontal. Bend the last 1.6mm of all pins back down to vertical. Trim off the narrow part of pins 1,2,3,7,8 & 13 then install on the back of U1 with pin 1 over hole 28. Solder all untrimmed pins to matching holes of U1 then finish soldering the 28 pin DIL socket.

Because this logic chip is fitted directly to the back of the PCB, it's pin numbers are mirrored with respect to U1 hole numbers.

All supporting circuitry for the Ramona BIOS is now installed. Test your work by fitting the BIOS chip in U1. Try the dev cart in an unmodified 7800 console. The Ramona cart menu should display.

Temporarily jumper U2 pins 1,2 & 26 to pin 28(+5V) and try the dev cart as a 2K/4K type. You should be able to upload and play a 4K game.

After testing, remove the temporary jumper on U2.

27) Jumper U1(Back) pin 1 to U1 pin 5(A5).
 28) Jumper U1(Back) pin 3 to U1 pin 21(A10).
 29) Jumper U1(Back) pin 7 to U1 pin 14(Gnd).
 30) Take a miniature, single pole, dual toggle (SPDT) switch and fit it in the front of the cartridge case. A slide switch is preferred. Probably the best

location for the switch is at either side of the PCB approximately 12mm from the side of the case and 44mm from the top end of the case. Remove the switch again until the dev cart mod is finished.

- 31) Take a 74LS374 logic chip, bend pins 1,2,3,4,5,7,11, 12,13,15,16,18 and 19 up to horizontal. Trim off the narrow part of pins 8 & 20 (to make installation easier) then install at U5.
- 32) Jumper the central pole of the SPDT switch to U5 pin 1(OE-).
- 33) Jumper one switching pole of the SPDT switch to U3 pin 14(+5V) on the back of the PCB. (This is the bankswitching "Off" position for 2K & 4K games).
- 34) Jumper the remaining switching pole of the SPDT switch to U3 pin 10(R/W-) on the back of the PCB. (This is the bankswitching "On" position for 8K/F8 & 16K/F6 games).
- 35) Jumper U5(LS374) pin 4 to U1 pin 10(A0) on the back of the PCB.
- 36) Disconnect the jumper leading to U3 pin 13. Take a 74LS32 logic chip, bend pins 1,2,3,4,5,6,8, 10,11 & 12 up to horizontal. Bend the narrow part of pin 13 so that it fits neatly against the matching pin on U3(LS02) when the two are placed together.

Install on top of U3(LS02). Solder pin 13 and all remaining vertical pins to matching pins on the bottom chip. Reattach the jumper leading to pin 13.

- 37) Take a 74LS08 logic chip, bend pins 1 to 6 & 8 to 13 up to horizontal then install on top of U4(LS00).
- 38) Using a 3.3K Ω resistor, jumper U4(Top) pin 13 to the bottom hole reserved for R3 (+5V).
- 39) Using a 3.3K Ω resistor, jumper U4(Top) pin 10 to the bottom hole reserved for R5 (+5V).
- 40) Jumper U3(Top) pin 8 to U4(Top) pin 12.
- 41) Jumper U3(Top) pin 10 to U2 hole 26(A13).
- 42) Jumper U4(Top) pin 10 to U5(LS374) pin 5.
- 43) Jumper U4(Top) pin 9 to U2 hole 2(A12).
- 44) Take a 74LS138 logic chip and bend pins 1,2,4,5,6,7 10,11,12,13 & 15 up to horizontal. This chip is to be installed on top of U5(LS374) with pin 1 over hole 1. Bend the narrow part of pins 3,9 & 14 so that they fit neatly against matching pins on U5(LS374) when the two are placed together.

Install on top of U5(LS374). Solder pins 3,9,14 and all remaining vertical pins to matching pins on the bottom chip.

- 45) Jumper U1(Back) pin 2 to U1 pin 6(A4).
- 46) Jumper U1(Back) pin 8 to U5(Top) pin 5.
- 47) Jumper U5(Top) pin 2 to U2 pin 8(A2).
- 48) Jumper U4(Top) pin 13 to U5(Bottom,LS374) pin 2.

- 49) Jumper U5(Top & Bottom) pin 3 to U2 pin 7(A3).
- 50) Jumper U5(Top) pin 4 to U4(Bottom) pin 3 on the back of the PCB.
- 51) Jumper U5(Top) pin 1 to U2 pin 9(A1).
- 52) Jumper U5(Top) pin 6 to pin 16(+5V).
- 53) Jumper U5(Top) pin 11(y4) to U4(Top) pin 5.
- 54) Jumper U4(Top) pin 6 to U5(Bottom,LS374) pin 11.
- 55) Jumper U4(Top) pin 8 to U2 pin 2(A12).
- 56) Jumper U4(Top) pin 11 to U2 pin 26(A13).
- 57) Bridge U5(Bottom) pin 7 to 8.
- 58) Take a (second) miniature SPDT switch and fit it in the front of the cartridge case. Locate to the side of the PCB opposite the switch installed per Step #30. Remove again until the dev cart mod is finished.
- 59) Jumper the central pole of the SPDT switch to U4(Top) pin 4.

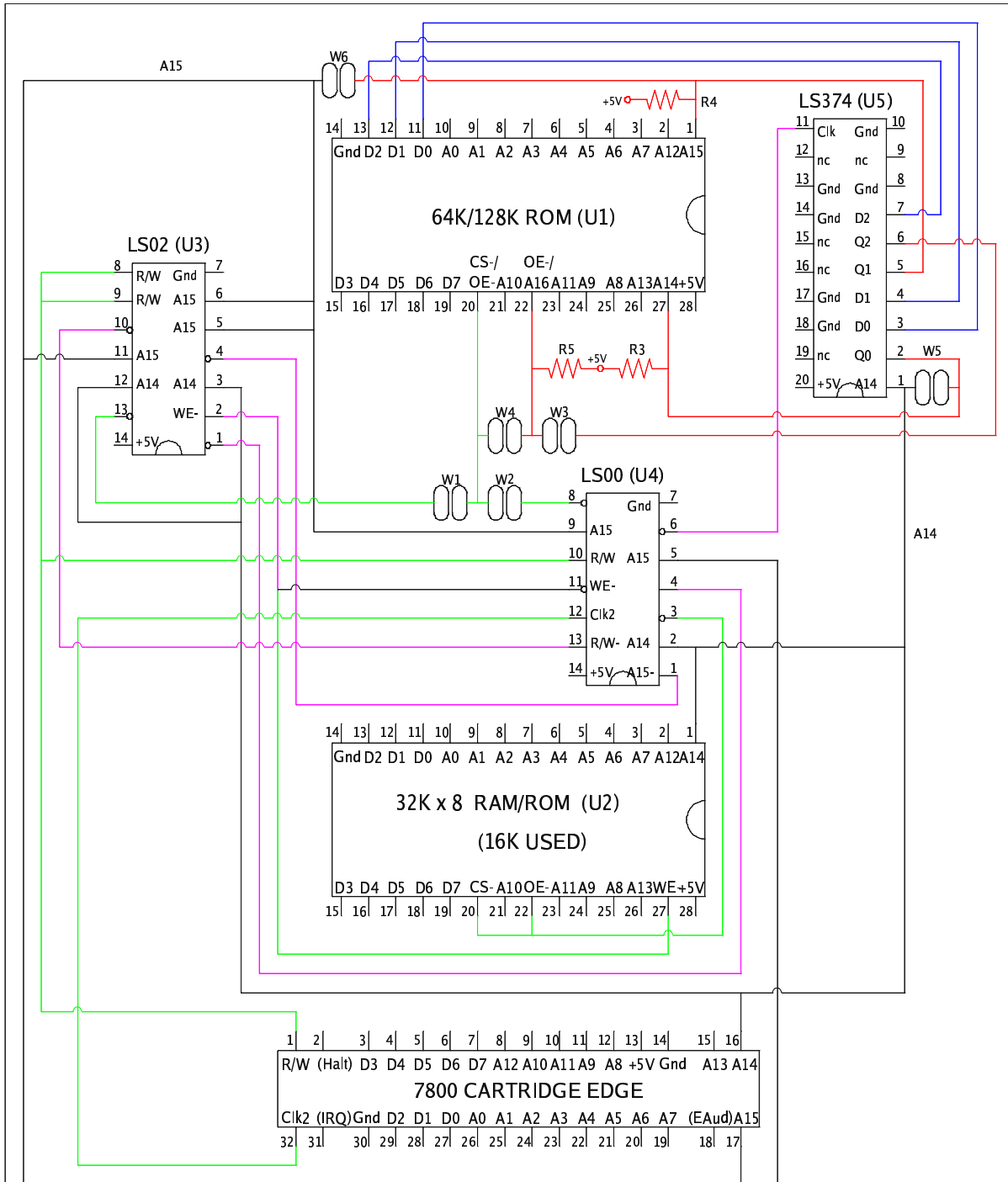
- 60) Jumper one switching pole of the SPDT switch to U5(Top) pin 12(y3). (This is the 16K/F6 position).
- 61) Jumper the remaining switching pole of the SPDT switch to the bottom hole reserved for C5 (+5V). (This is the 8K/F8 position).
- 62) Jumper U2 pin 1(A14) to U2 pin 28(+5V).

TROUBLESHOOTING:-

The 4K program "Test Pattern" (color bar generator) by Video Soft should upload and play for both 8K/F8 and 16K/F6 settings. The program should work whether cartridge bankswitching is functioning or not, so this can be used to verify that at least 4K is successfully uploaded with bankswitching enabled. (Use 7800ctrl -f filename.bin).

17. Appendix

17.1 Circuit Diagram for PCB No. C300565-XXX



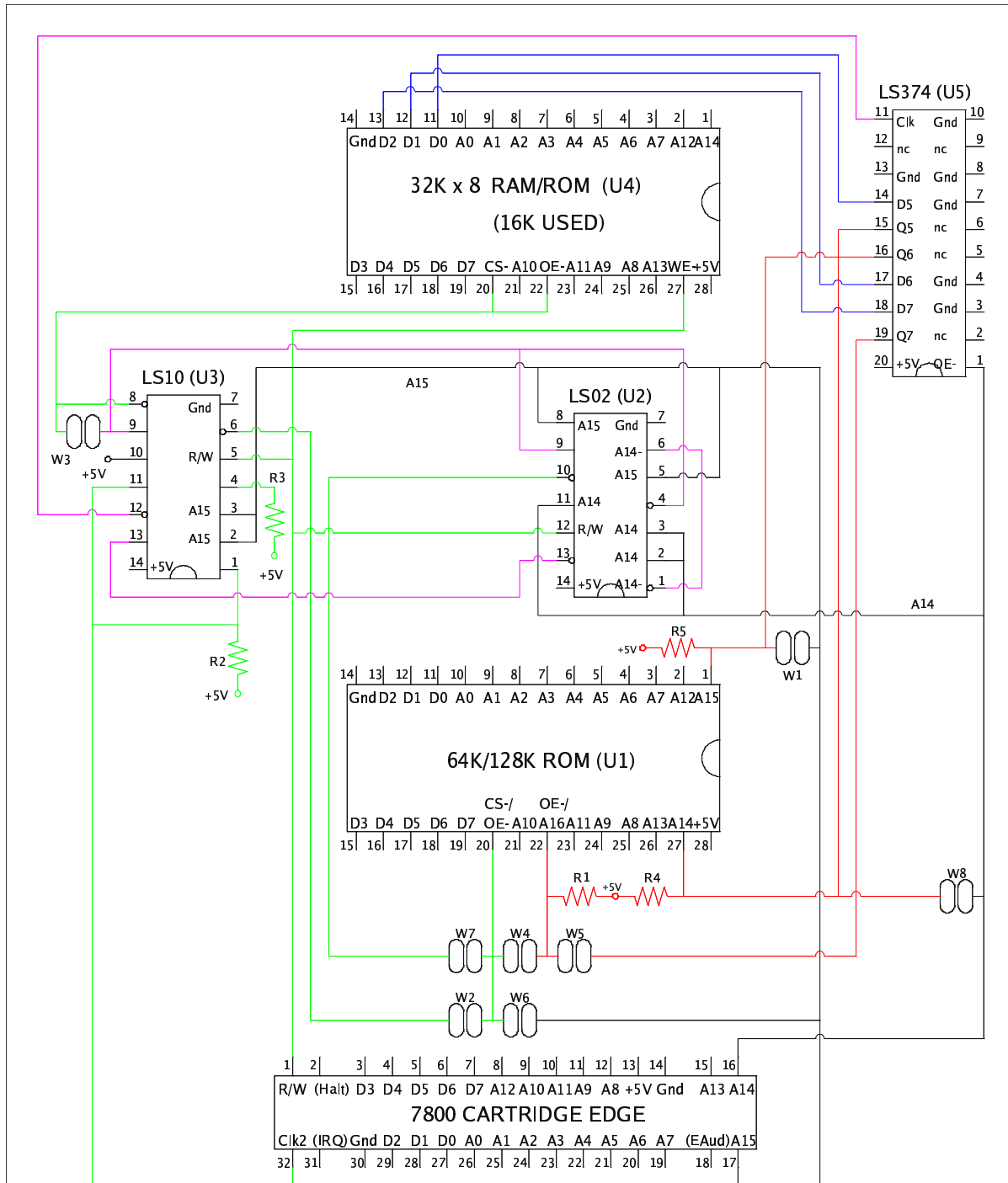
LEGEND:- Address
 Data
 Chip select & I/O control
 Bankswitch control
 Gate to gate



NOTES:- 1/ All address lines A0-A13 and all Data lines D0-D7 are connected from the cartridge edge to U1 and U2. All other connections as shown.
 2/ Halt, EAudio and IRQ are not used.

TITLE:- PCB Part No. C300565-XXX
 DRAWN:- G.Percy with QCad DATE:- 12th Nov 2002

17.2 Circuit Diagram for PCB No. C100339



LEGEND:-
 Address ———
 Data ———
 Chip select & I/O control ———
 Bankswitch control ———
 Gate to gate ———

NOTES:-
 1/ All address lines A0-A13 and all Data lines D0-D7 are connected from the cartridge edge to U1 and U4. All other connections as shown.
 2/ Halt, EAud and IRQ are not used.

TITLE:- PCB Part No. C100339	
DRAWN:- G.Percy with QCad	DATE:- 15th Dec 2002

17.3 Logic Diagrams

DESIGNATION	LOGIC ELEMENT DESCRIPTION
LS00	2-input NAND
LS02	2-input NOR
LS08	2-input AND
LS10	3-input NAND
LS20	4-input NAND
LS30	8-input NAND
LS32	2-input OR
LS138	3-to-8 line demultiplexer
LS139	2-to-4 line demultiplexer
LS174	D-type flip-flop with Clear. Positive edge clock
LS175	D-type flip-flop with Clear and complementary output. Positive edge clock
LS374	Octal D-type flip-flop, positive edge clock

Table 8 Description of Logic Elements

GENERAL NOTES CONCERNING LOGIC CIRCUIT DESIGN:-

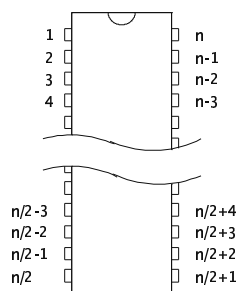
1. There is usually more than one way of achieving a particular logical output. This can be used to minimize the number of logic chips required by making best use of the gates available on each chip. eg. A 74LS00 has four 2-input NAND gates.
2. All address lines leading to an SRAM are interchangeable amongst themselves. This is because the same connections used for upload are used for game play. The same holds true for data lines.

Address and data lines are not interchangeable on an EPROM since they are determined when the EPROM is programmed.

3. A high value resistor which connects a logic line either to earth or +5V will pull the logic level of the line low (0V) or high (+5V) respectively whenever the line is not driven.

SIGNAL NAME	CONVENTION
Address	A0....16
Data	D0....7
Clock	CP
Chip Select (Active Low)	\overline{CS}
Output Control (Active Low)	\overline{OC}
Output Enable (Active Low)	\overline{OE}
Write Enable (Active Low)	\overline{WE}

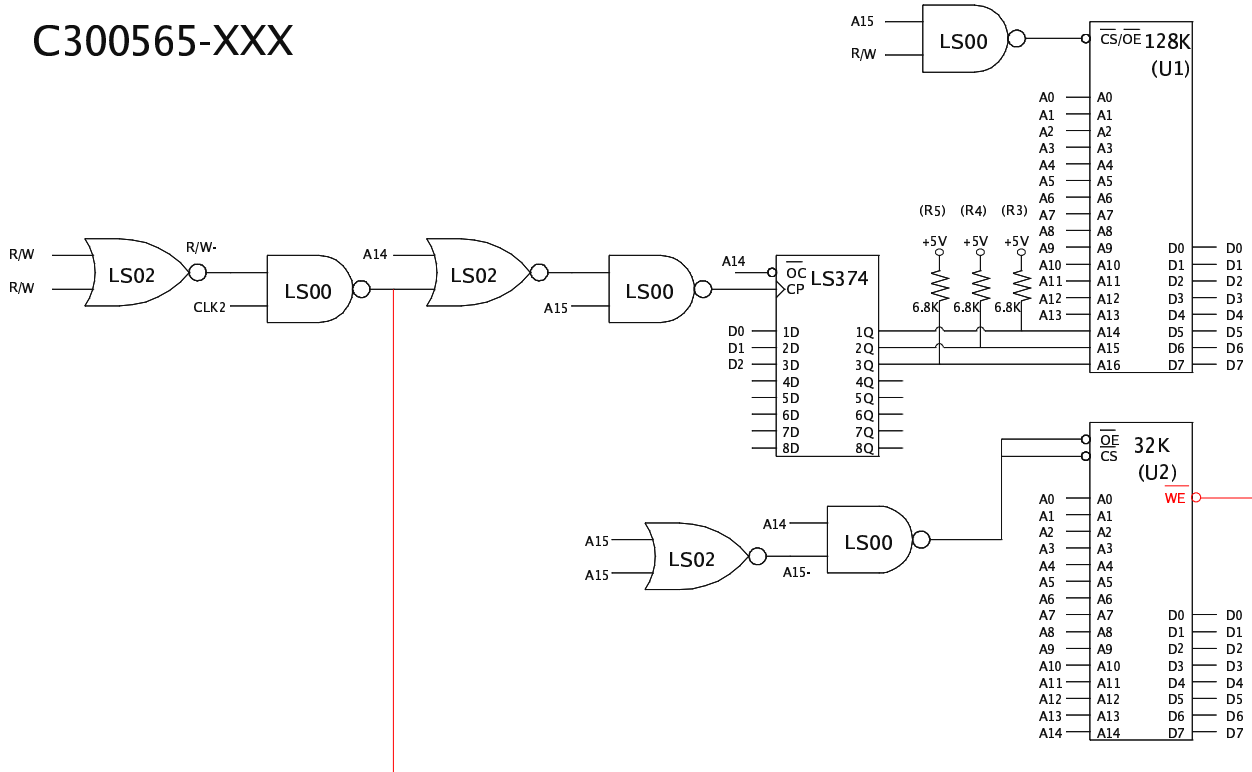
Table 9 Signal Naming Conventions



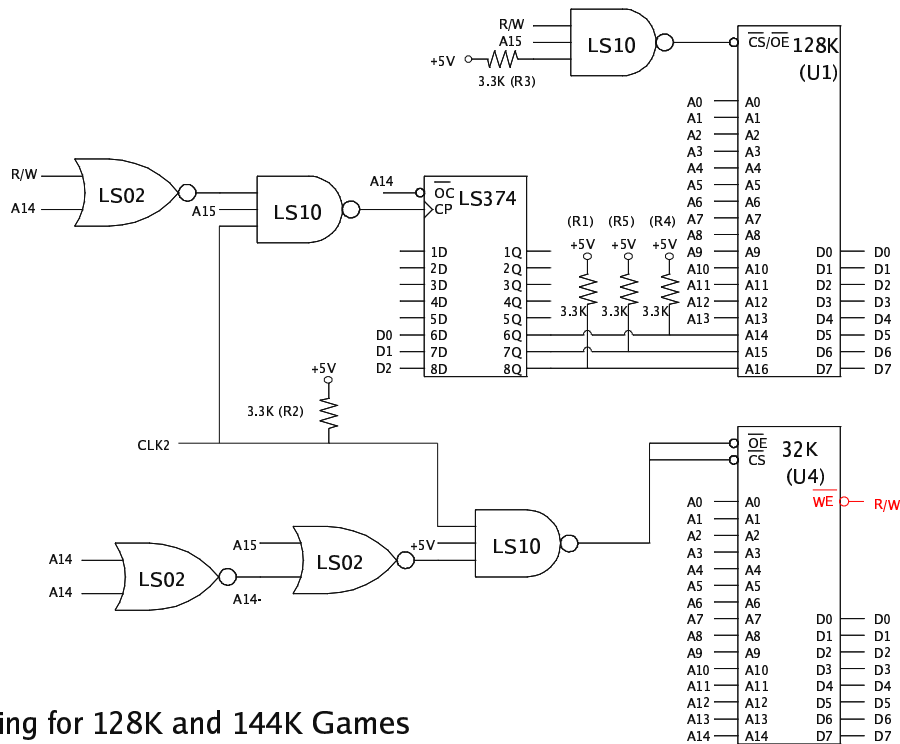
Conventional DIP package pin numbering

17.3.1 Atari Super Game Cartridge Logic

C300565-XXX



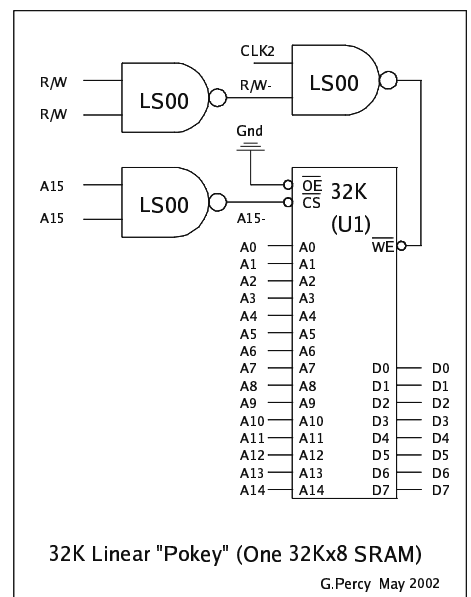
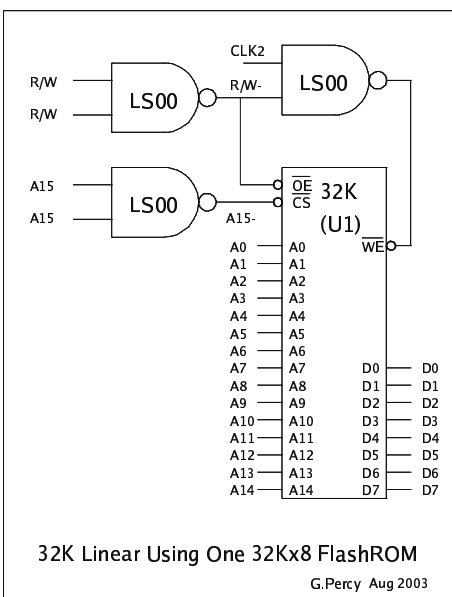
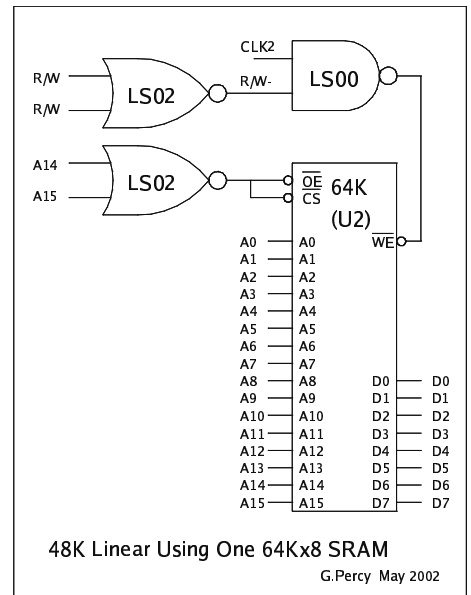
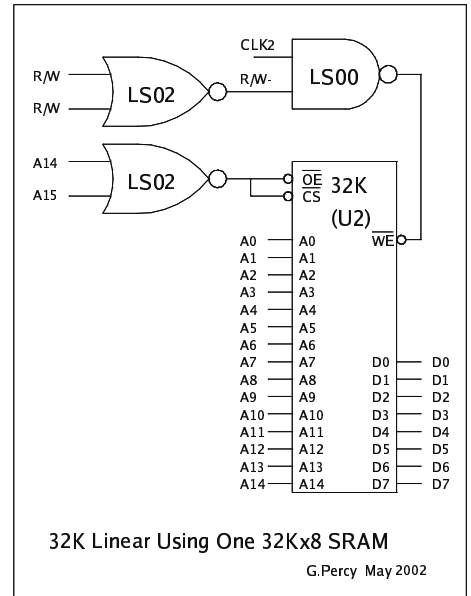
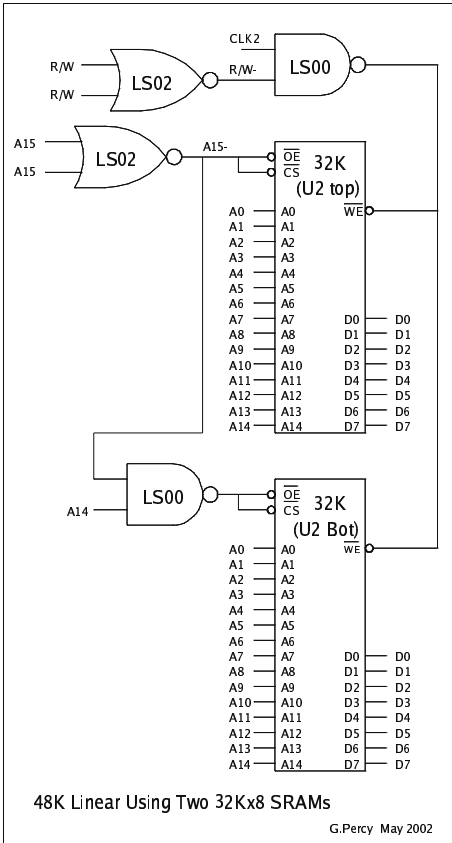
C100339

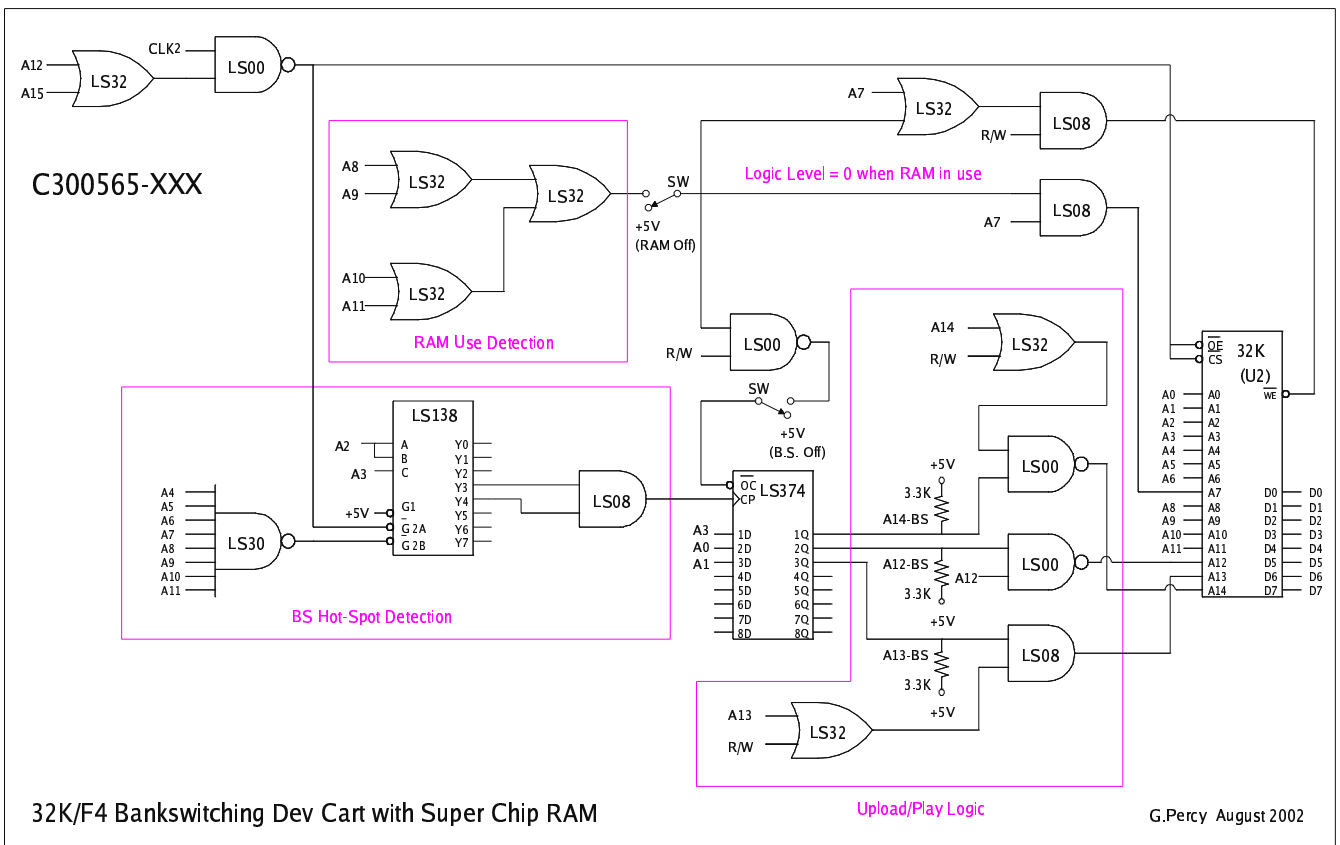
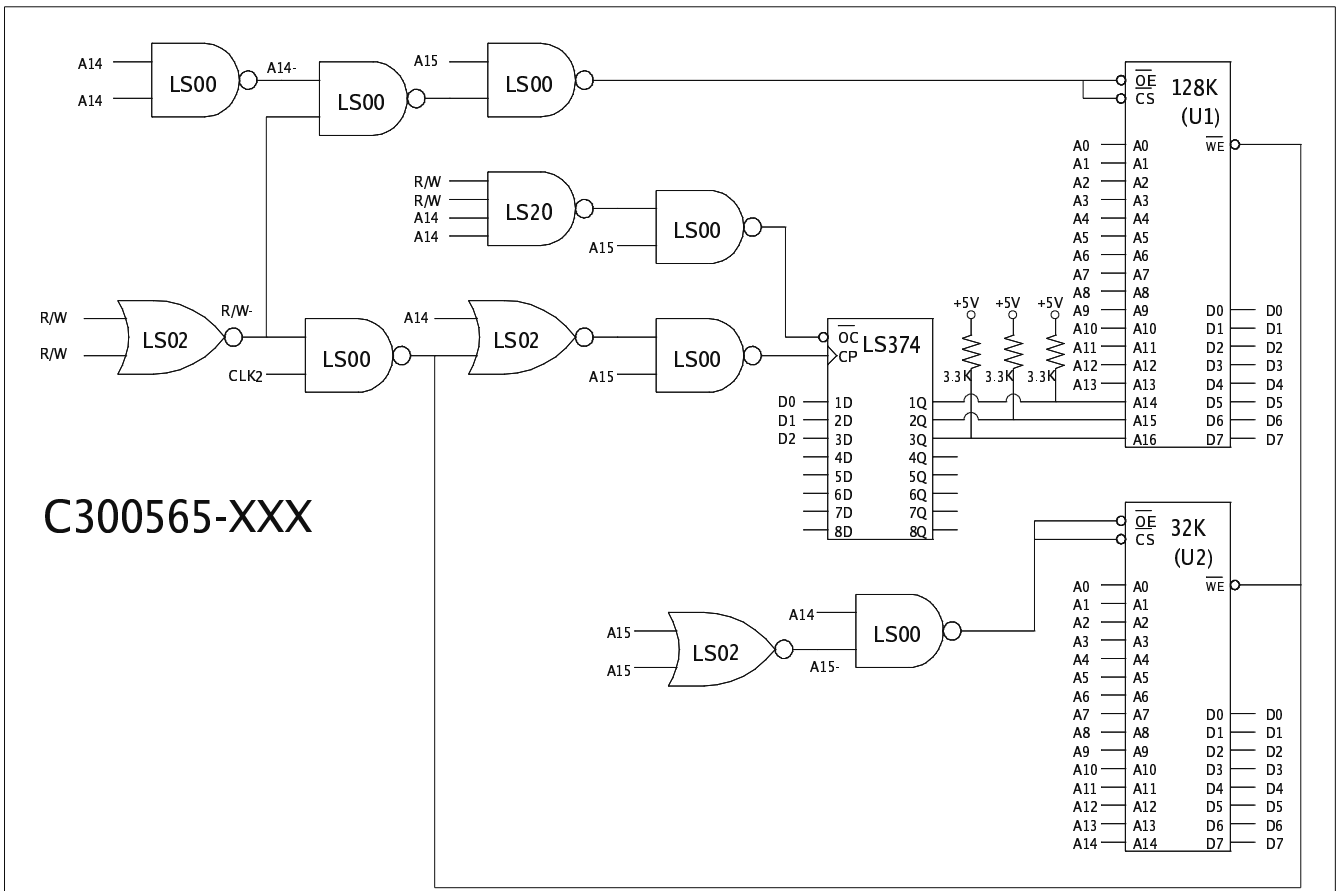


Original Atari Bankswitching for 128K and 144K Games

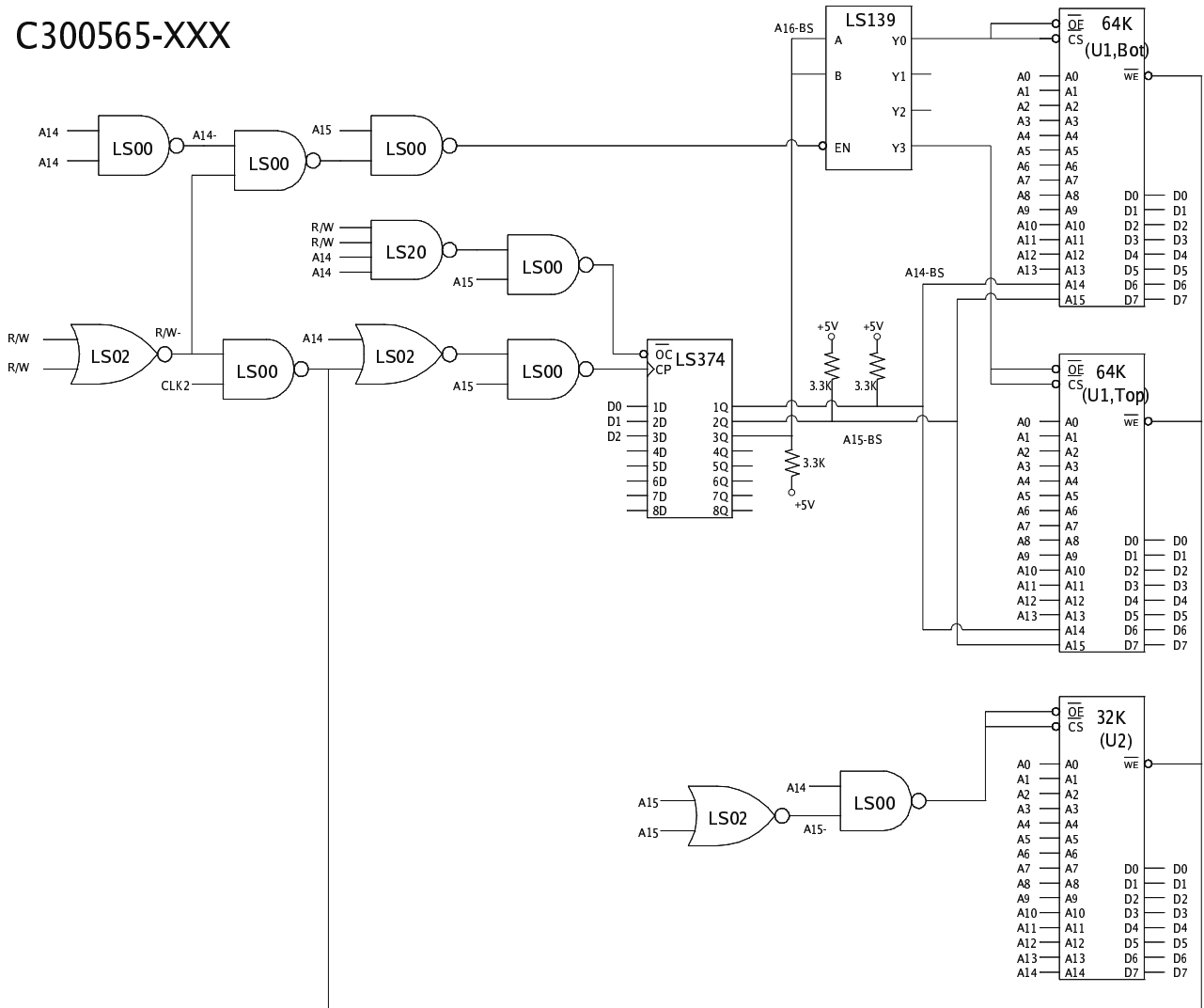
(Red circuit elements are provided for games using RAM in U4)

17.3.2 Dev Cart Logic





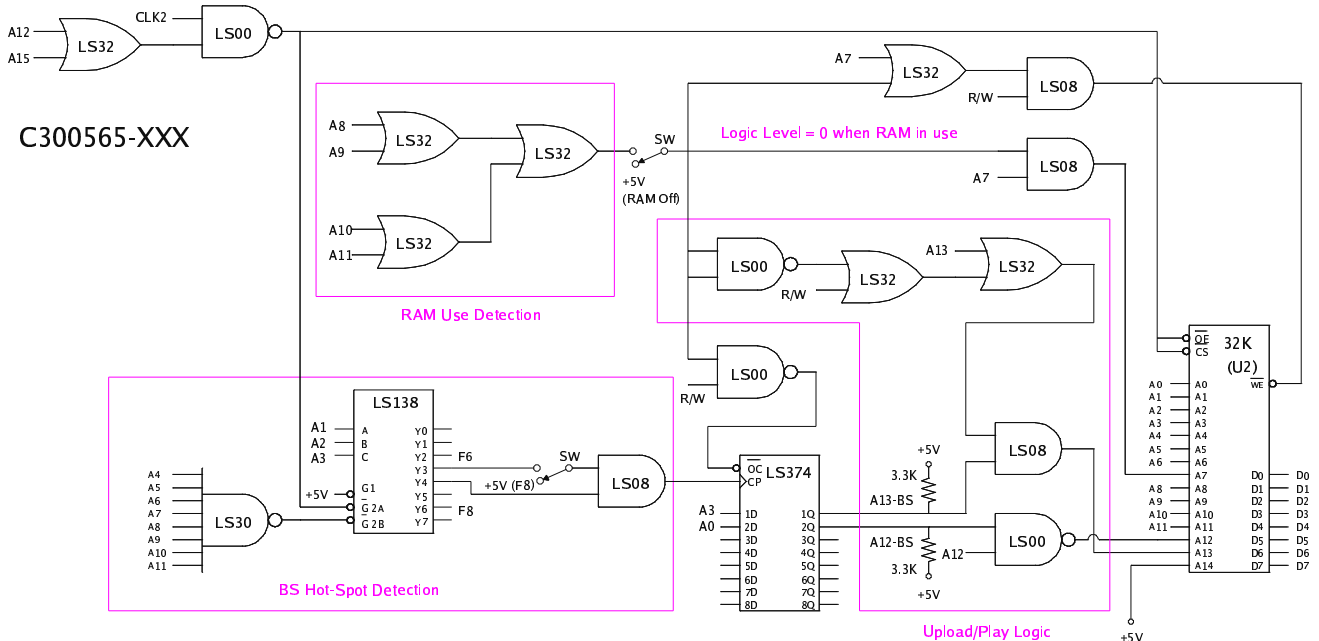
C300565-XXX



144K Bankswitching Dev Cart Using Two 64Kx8 SRAMs in U1

G.Percy May 2002

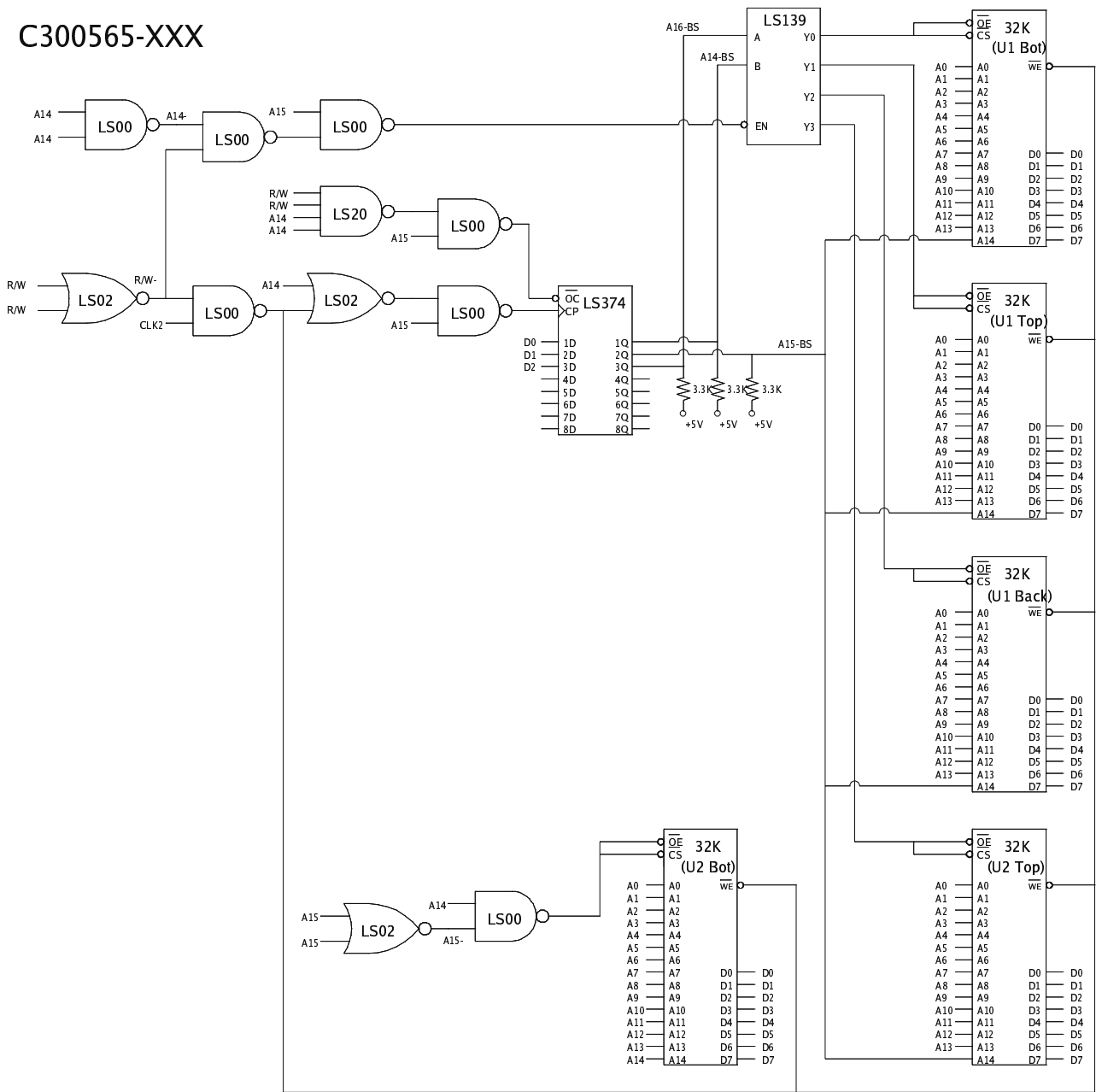
C300565-XXX



Combined 8K/F8 & 16K/F6 Bankswitching Dev Cart with Super Chip RAM

G.Percy July 2002

C300565-XXX

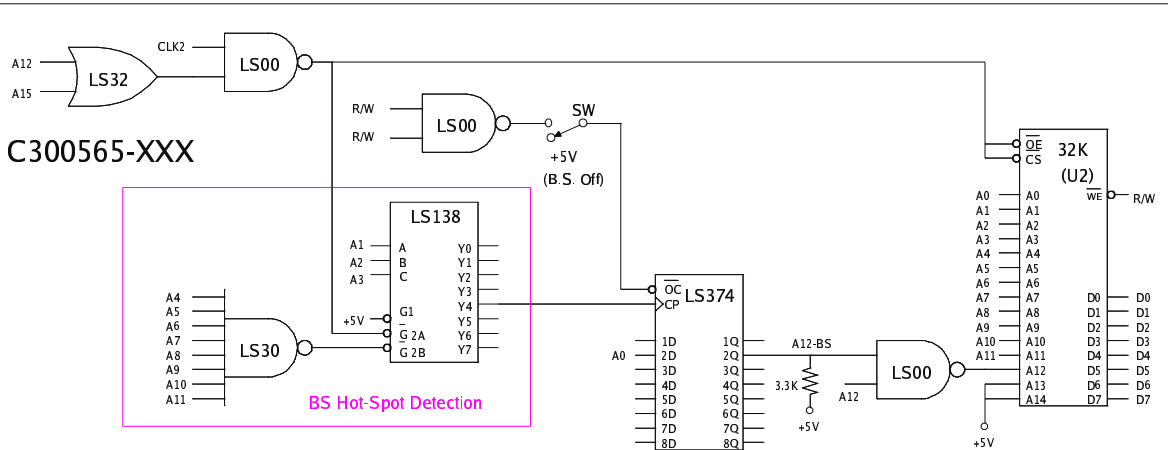


144K Bankswitching Dev Cart Using Four 32Kx8 SRAMs (in place of U1)

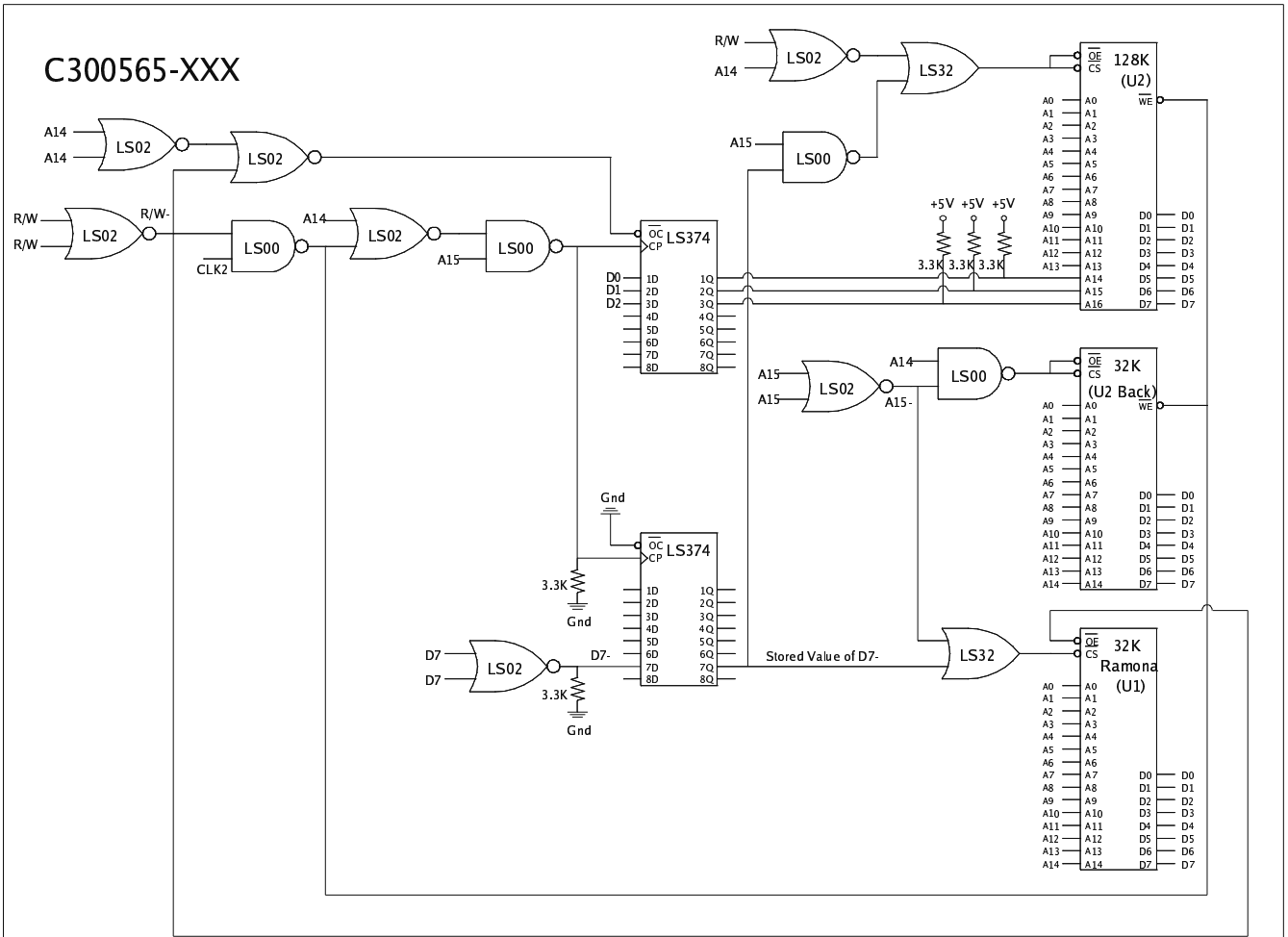
G.Percy May 2002

C300565-XXX

8K/F8 Bankswitching Dev Cart

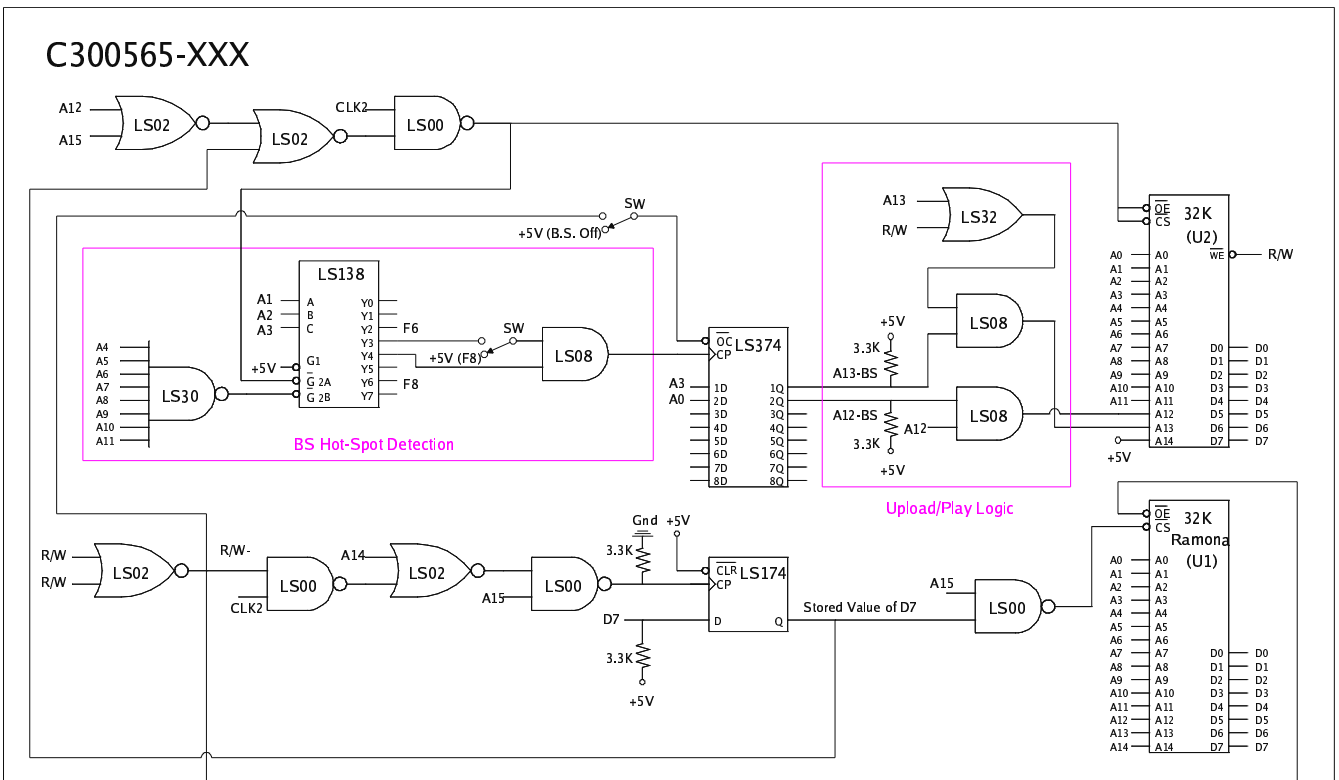


G.Percy July 2002



144K Bankswitching Dev Cart with built-in BIOS, using one 128Kx8 SRAM

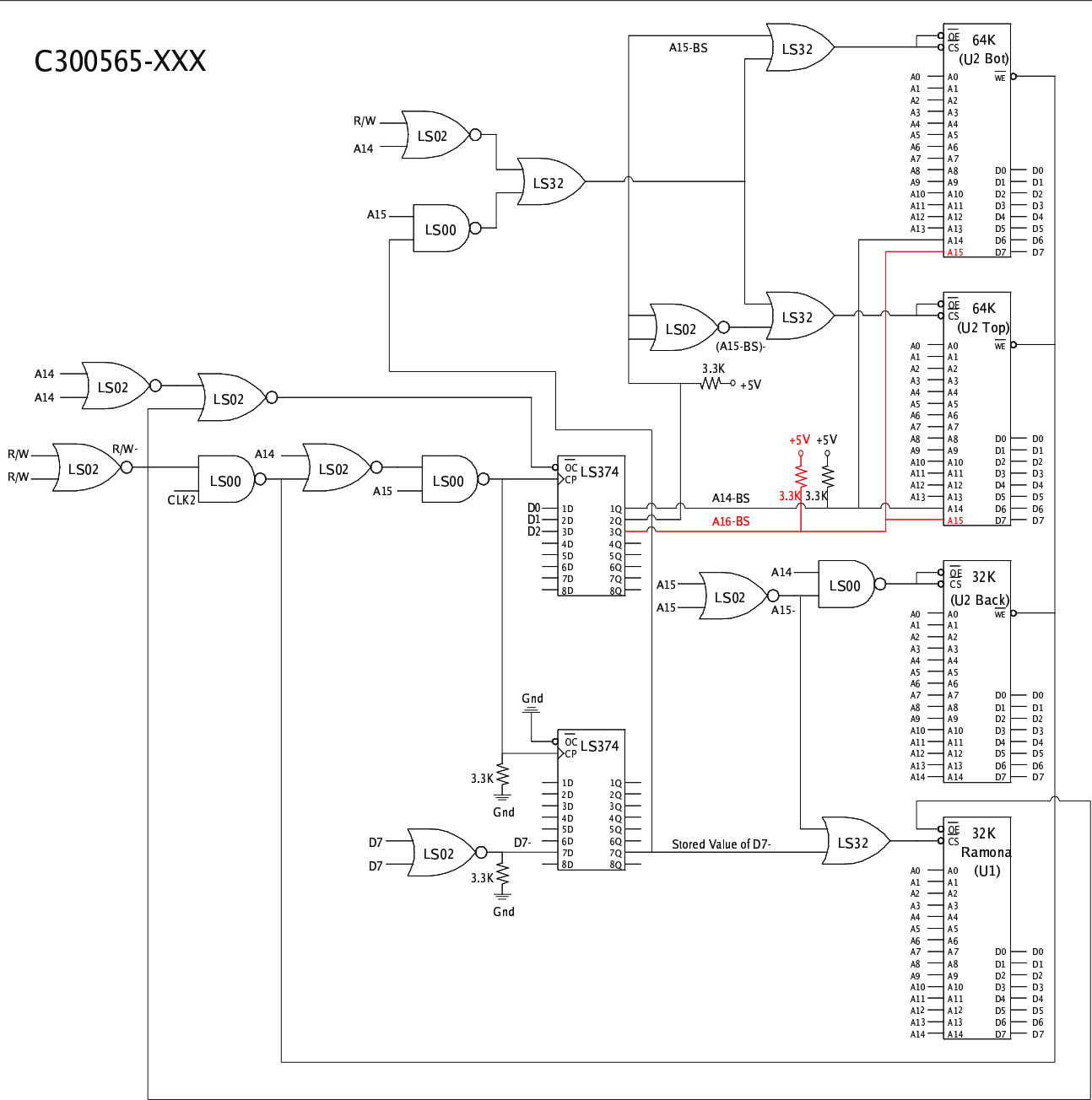
G.Percy Sept 2002



Combined 2K/4K , 8K/F8 & 16K/F6 Bankswitching Dev Cart with built-in BIOS

G.Percy Jan 2003

C300565-XXX

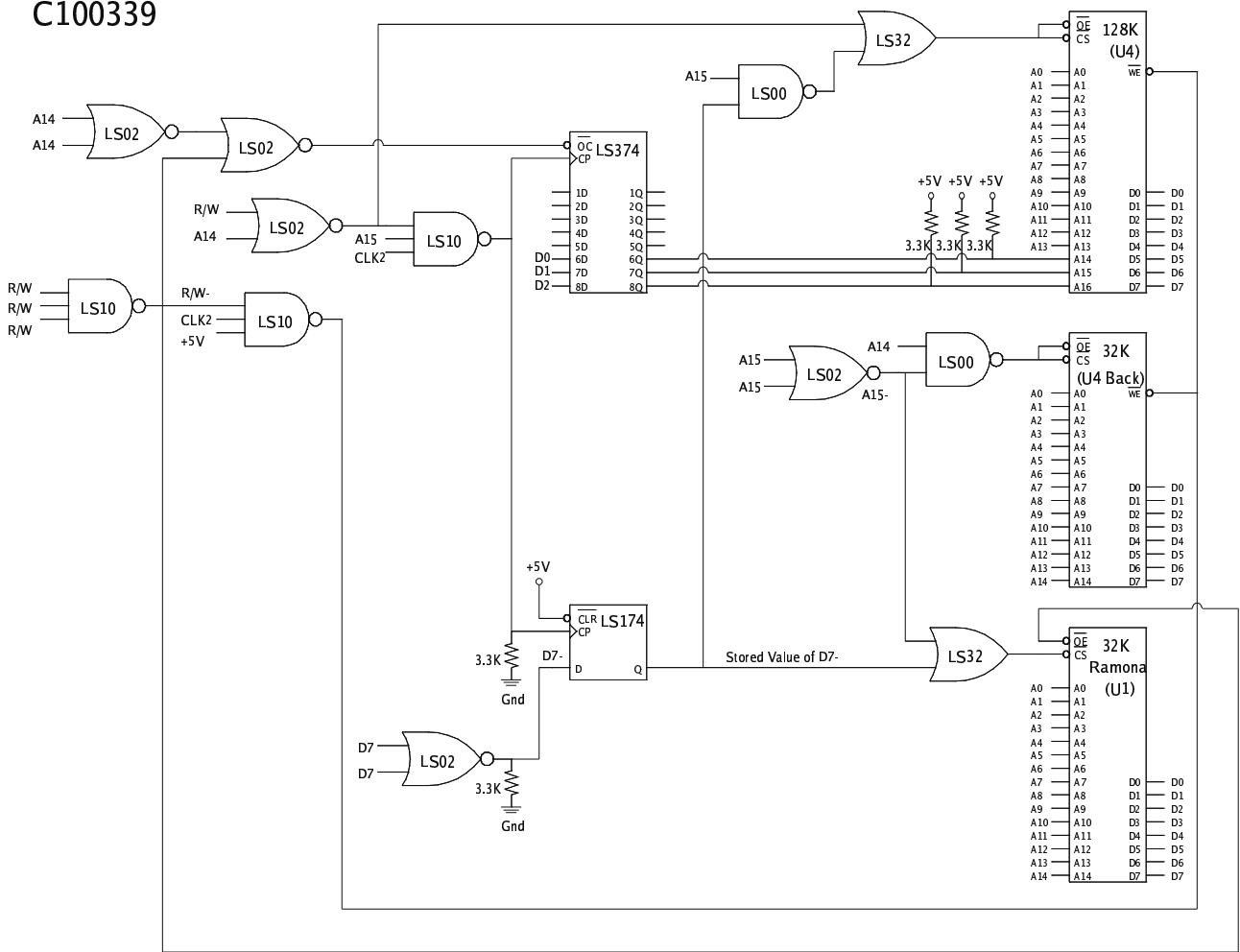


144K Bankswitching Dev Cart with built-in BIOS, using two 64Kx8 SRAMs

(Circuit elements shown in Red are omitted from the 64K version which uses 2x32K SRAMs)

G.Percy Sept 2002

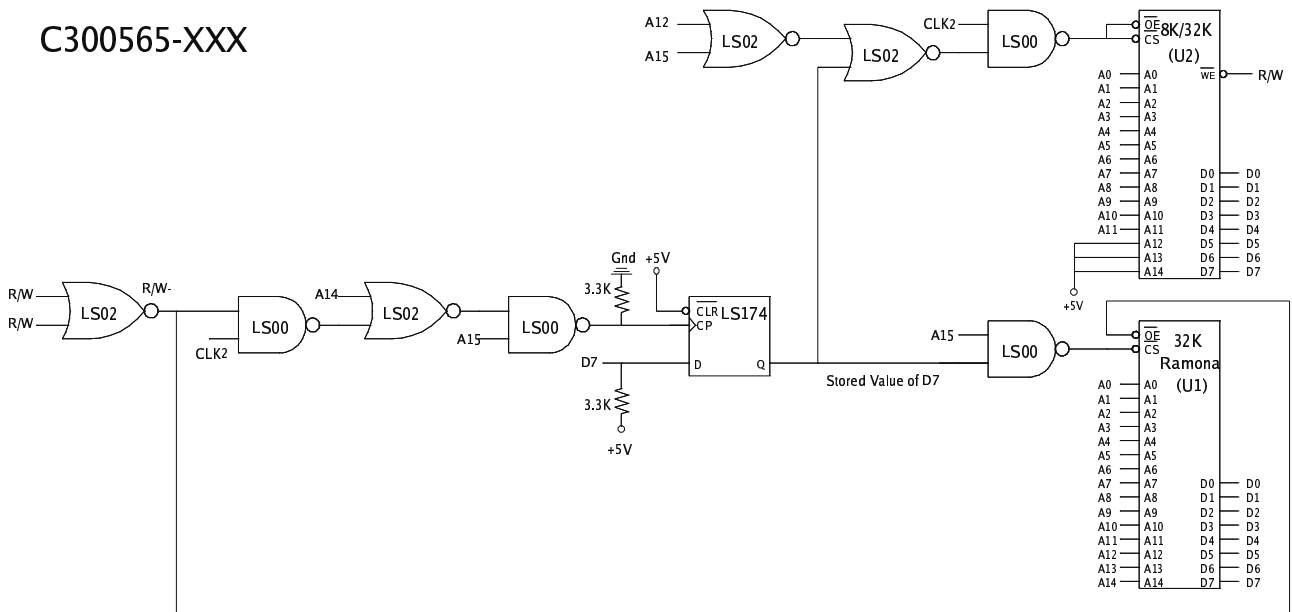
C100339



144K Bankswitching Dev Cart with built-in BIOS, using one 128Kx8 SRAM

G.Percy Sept 2002

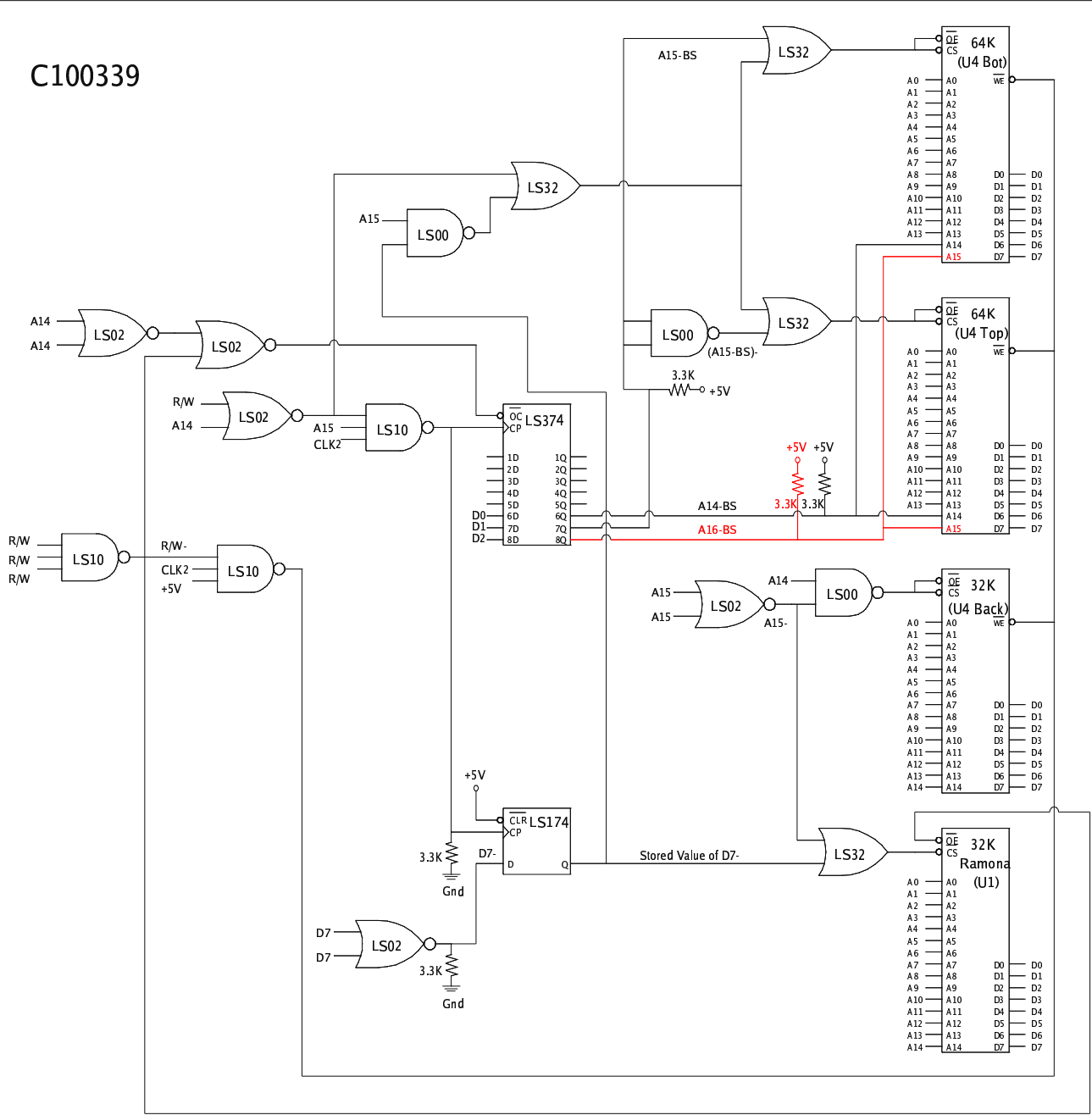
C300565-XXX



2K/4K Linear Dev Cart with built-in BIOS

G.Percy Jan 2003

C100339



144K Bankswitching Dev Cart with built-in BIOS, using two 64Kx8 SRAMs

(Circuit elements shown in Red are omitted from the 64K version which uses 2x32K SRAMs)

18. Acknowledgments

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- Thanks to Cye Freeman for drawing attention to a flaw in jumpering on the linear devcart made by using existing built-in RAM (Section 8.)