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two 4KB banks gives the system a possible 8KB of accessible data space. If the game accesses address 1FF8, the first 4KB bank is used. If the game accesses address 1FF9, the second 4KB bank is used.

The F6 scheme is identical in theory to F8, except there are four "hot spots" defined to switch between four unique 4KB memory banks. Having four 4KB banks gives the system a possible 16KB of accessible data space. If the game accesses address 1FF6, the first 4KB bank is used. If the game accesses address 1FF7, the second 4KB bank is used. If the game accesses address 1FF8, the third 4KB bank is used. If the game accesses address 1FF9, the fourth 4KB bank is used.

The F4 scheme is also identical in theory to F8 and F6, except there are eight "hot spots" defined to switch between eight unique 4KB memory banks. Having eight 4KB banks gives the system a possible 32KB of accessible data space. The banks are selectable by accessing one of eight addresses from 1FF4 to 1FFB.

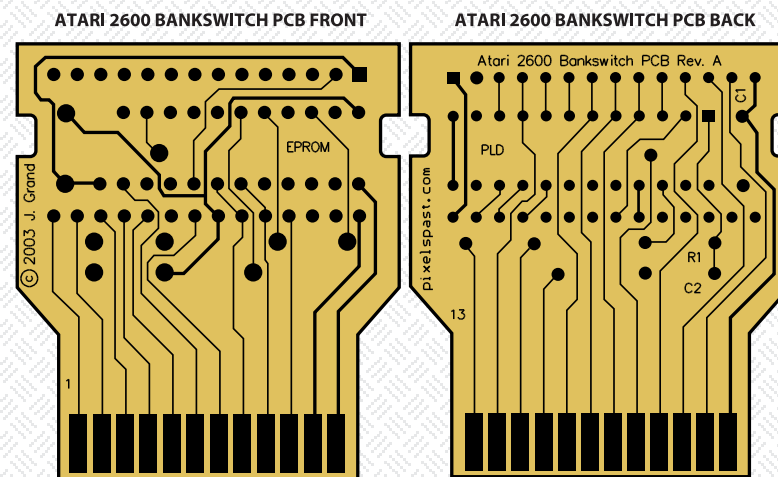
Many other types of Atari 2600 bankswitching schemes exist. For detailed descriptions, refer to [www.tripoint.org/kevtris/files/sizes.txt](http://www.tripoint.org/kevtris/files/sizes.txt) written by Kevin Horton.

Additionally, the Atari 2600 was designed to use special ROM (Read-Only Memory) devices which implement an active-high Chip Enable (CE) line. Currently available memory devices, such as the commonly used EPROM (Erasable Programmable Read-Only Memory, which are erasable with UV light and reprogrammable) use an active-low CE line. Because of this, an inverter is needed to change the logic level of CE as it comes from the Atari 2600 before it is connected to the EPROM. The programmable logic within U2 is used to invert the A12 address line, which is used by the Atari 2600 as the Chip Select.

R1 and C2 form an RC time delay of 220nS, which gives the address bus signals from the Atari 2600 time to settle before they are read by U2. The delay helps to prevent glitches in cartridge operation and ensures that the correct address is actually specified on the bus before the switching of banks occurs.

C1 serves as a bypass/decoupling capacitor to help reduce electrical noise on the power supply line coming from the Atari 2600 system. The circuit will

function without C1, but voltage spikes could cause irregularities in cartridge operation, so it is highly recommended to install it.



#### DISCLAIMER:

Pixels Past does not assume any liability arising out of the application or use of any product or circuit described herein. Pixels Past guarantees that the printed circuit boards are electrically tested and meet physical design and manufacturing requirements. Pixels Past warrants to replace any unmodified circuit board proven to be flawed. Pixels Past is not responsible for improper use or placement of components, incorrect soldering techniques, damage to systems, or other assembly or electronics issues. Pixels Past reserves the right to make changes without further notice to any products herein to improve reliability, function, or design.

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# ATARI 2600

PIXELS PAST ATARIAGE 8K/16K/32K PCB ASSEMBLY

#### FEATURES:

- Create 8K, 16K, and 32K games for the Atari® 2600™ system
- Supports standard Atari F8, F6, and F4 bankswitching schemes
- Uses easily available, off-the-shelf components
- Fits into standard Atari 2600 cartridge cases
- Build new 2600 games without modifying old cartridge circuits

#### DESCRIPTION:

Pixels Past's Atari 2600 8K/16K/32K PCB (Printed Circuit Board), also known as the Atari 2600 Bankswitch PCB, provides homebrew game authors with an easy method of creating their own videogame cartridges. The PCB, which fits in standard Atari 2600 cartridge cases and works on any Atari 2600 or compatible system, supports any 8KB, 16KB, or 32KB Atari game binary that uses the standard Atari F8, F6, or F4 bankswitching schemes. These boards have been designed with the hobbyist in mind - they are simple to assemble and have extremely high-reliability. They have been tested with the most stubborn Atari 2600 systems.

The Atari 2600 Bankswitch PCB is easily assembled by anyone with basic soldering skills, and most of the required components are included with your purchase from AtariAge. The Atari 2600 Bankswitch PCB is designed for game developers who do not want to go through the hassle of modifying old cartridge circuit boards. These are brand new boards designed by Pixels Past ([www.pixelspast.com](http://www.pixelspast.com)), not recycled boards from old games.

10 INCHES

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AtariAge ([www.atariage.com](http://www.atariage.com)) provides homebrew services to build and assemble game cartridges. They can also design and produce full-color manuals and labels.

### BILL OF MATERIALS:

The following parts are required to create a functional Atari 2600 game cartridge. All components, except for U1, should have been included with your purchase from AtariAge. Components can also be found at most local electronics stores and large on-line distributors such as Digi-Key ([www.digikey.com](http://www.digikey.com)) or Jameco ([www.jameco.com](http://www.jameco.com)).

DESIGNATOR	PART NUMBER	DIGI-KEY	DESCRIPTION
U1	2764(A), 27128(A) or 27256(A)	N/A	EPROM (programmed with game binary). CMOS OK, 100nS - 250nS.
U2	20V8 Complex Programmable Logic Device (PLD)	ATF20V8B-10PC-ND	Recommended device: Atmel ATF20V8B, 24-pin DIP (*see note)
C1	0.1µF Ceramic	399-1880-1-ND	Bypass capacitor (104), axial leads
C2	100pF ceramic	399-1812-1-ND	Time delay capacitor (101), axial leads
R1	2.2k ohm resistor, 1/8W	2.2KEBK-ND	Time delay resistor (red-red-red)
PCB	Atari 2600 Bankswitch PCB	N/A	Pixels Past cartridge PCB

\* Must be programmed with Pixels Past bankswitching code, specify 8K, 16K, or 32K when ordering from AtariAge.

### ASSEMBLY INSTRUCTIONS:

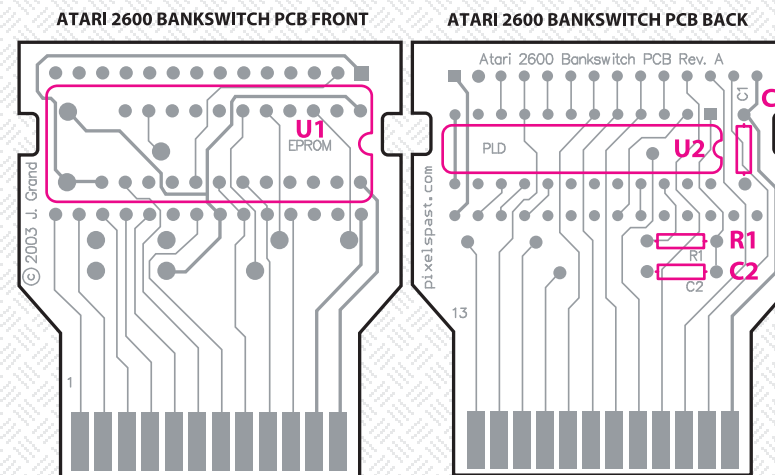
Assembly of the Atari 2600 Bankswitch PCB is simple, but requires basic soldering skills. The order of parts placement and soldering of the devices onto the PCB is critical.

Pin 1 of the ICs (Integrated Circuits, in this case U1 and U2) is denoted by a square pad on the circuit board. Please refer to the separate Basic Assembly

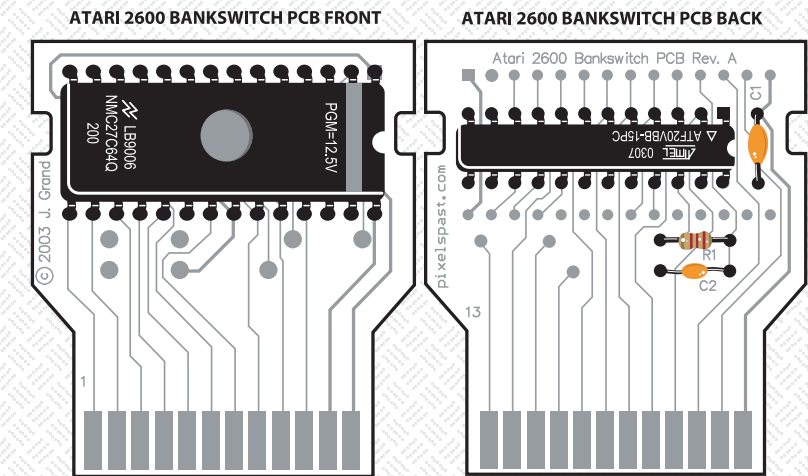
Techniques pamphlet for more information.

1. Insert and solder U2 to the backside of the board.
2. Insert and solder C1 to the backside of the board. C1 should be a small-footprint axial leaded device in order to fit properly onto the circuit board and into the cartridge housing.
3. Insert and solder R1 to the backside of the board. R1 should be a 1/8 watt resistor for an ideal fit onto the circuit board and into the cartridge housing. A more easily available 1/4 watt resistor could be used, but care should be taken to not damage the component while bending the leads as close to the resistor body as possible.
4. Insert and solder C2 to the backside of the board. C2 should be a small-footprint axial leaded device in order to fit properly onto the circuit board and into the cartridge housing.
5. Insert U1 onto the opposite (front) side of the board and solder it into place. It is recommended that you place a UV-resistant sticker over the EPROM window to prevent accidental erasure of the code stored in the device.

### PARTS PLACEMENT:



THE COMPLETED, ASSEMBLED CIRCUIT BOARD SHOULD RESEMBLE THE IMAGES BELOW:



### THEORY OF OPERATION:

By design, the Atari 2600 has a 12-bit wide external address space and an 8-bit wide data bus, meaning that the Atari 2600 can support cartridges up to 4KB without any special circuitry. Bankswitching is a method used to overcome a memory size limitation (such as 4KB for the Atari 2600) and allows a larger size memory device to be used with a cartridge, thus providing more data storage for the system. Bankswitching requires specially designed logic circuitry on the cartridge to handle the specific schemes.

U2, a common family of PLD (Programmable Logic Device), serves this purpose. This device must be programmed with Pixels Past's bankswitch code (available exclusively from AtariAge) in order for the cartridge to work properly. The three standard Atari bankswitching schemes are supported on the Atari 2600 Bankswitch PCB: F8 (for 8K games), F6 (for 16K games), and F4 (for 32K games). The desired game size must be specified when ordering the Atari 2600 Bankswitch PCB from AtariAge.

The F8 scheme defines two "hot spots" used by the game program to switch between two unique 4KB memory sections (or banks) of the ROM. Having

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