Asteroids High Score Saver

Jürgen Müller, juergen@e-basteln.de, December 2015 Rev E

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Before you begin

Check your ROM version!

Atari has released different ROM versions for the Asteroids arcade game. The program code in the high score saver's onboard ROM must match the Asteroids ROM version.

The ROM version is most easily identified by running the game and observing the copyright message at the bottom of the screen: If it reads "ASTEROIDS BY ATARI", the ROMs are version -01. If it reads "© 1979 ATARI INC", the ROMs are version -02. Alternatively, you can look at the ROM chips on the Asteroids PCB. All ROMs should be marked with an -01 or -02 suffix to their part number (if they have the original Atari print or labels).

Different High Score Saver ROMs are available for ROM revision -01 and -02, respectively. Please make sure you have the right one! The High Score Saver for Asteroids revision -02 is also compatible with the "difficulty upgrade" Atari released later, as a modification of revision -02. This version (where the small saucer starts firing without delay as soon as it appears, among other changes) shows the same copyright message as the -02 revision. Two ROMs are different from the regular version -02, and should be labeled 035144-04E and 035145-04E for the more difficult version.

Required parts

- **Parallel EEPROM AT28C64B, 8k*8, 28 pin SOIC.**
  This should be pre-programmed before installation, with the right code version (see above). It can still be programmed later while installed on the PCB, but that requires the use of a custom programming adapter and the installation of the three extra pins on the short side of the PCB.

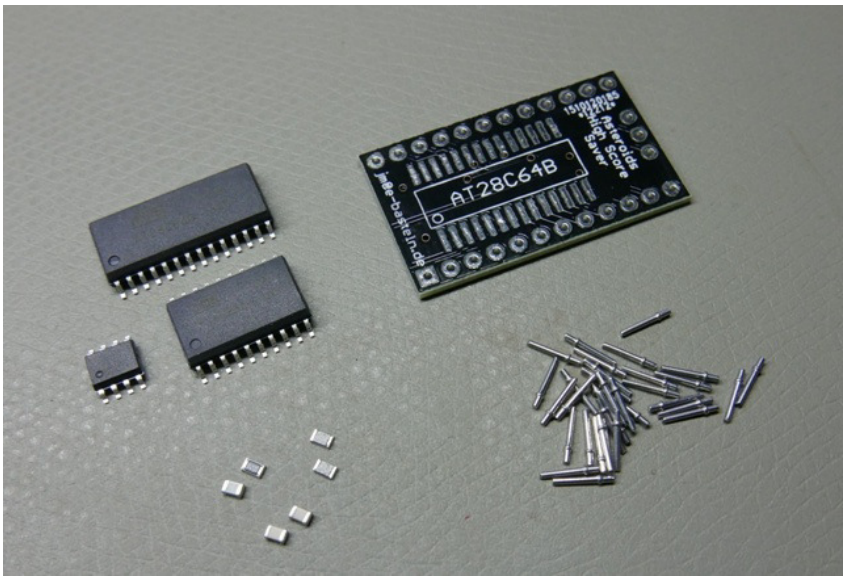
- **GAL ATF16V8, 20 pin SOIC.**
  This must be pre-programmed before installation; it cannot be programmed or re-

programmed once installed on the PCB. The GAL code is identical for Asteroids revisions -01 and -02.

- **Serial EEPROM 25LC010A, 128*8, 8 pin SOIC.**
  No pre-programming needed here. This will be initialized once the PCB is installed on the Asteroids board.
- **Capacitors and resistors, package size 0805 or 0603:**
  - **R1 = 820 Ohm, C1 = 100 pF.**
    Low-pass filter to remove glitches from the chip enable signal.
  - **R2 = R3 = 4700 Ohm.**
    Pullups for two control signals that are overridden when the PCB is installed in a programming adapter. Could be replaced by bridges if programming is never intended, but I recommend installing them to keep the PCB future-proof.
  - **C2 = C3 = 100 nF.**
    Decoupling capacitors to ensure a clean power supply for the ICs.
- 24 Pins to install in the DIP24 socket on the Asteroids board;
  3 more only needed for the on-board parallel EEPROM programming option (with external adapter). Please see the „Assembly“ section for a discussion of pin options.

Recommended Tools

Standard soldering equipment is sufficient: Temperature controlled, fine tip soldering iron; thin solder (not more than 0.5mm diameter); manual solder pump and solder wick to remove excess solder. An antistatic mat and wrist-band are recommended. A pair of tweezers and a small bench vise or other mount will be helpful for handling the SMD parts and supporting the little PCB.



Assembly

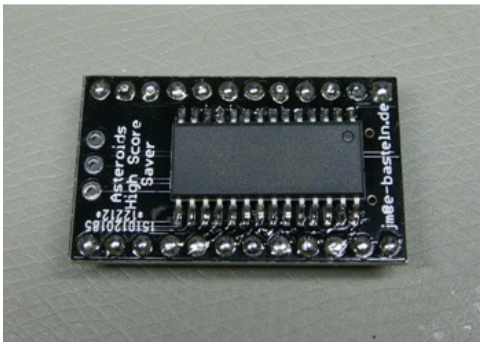
Integrated Circuits

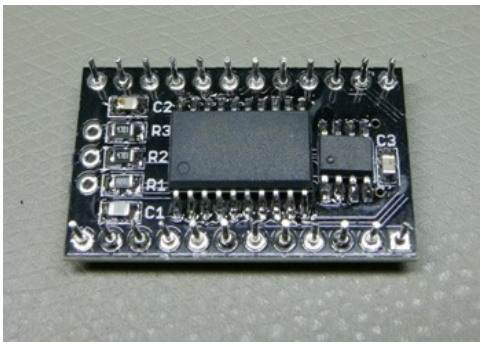
I recommend populating the integrated circuits first. The IC types are spelled out on the PCB silkscreen. Also, the three ICs all have different pin counts and footprints, so there is no danger of mixing them up. The silkscreen indicates the position of pin 1 of each IC by a little circle, and the IC bodies have dimples in the corresponding position.

SOIC packages are still large enough to be soldered pin by pin with a conventional soldering iron. If you have not done this before, there are many tutorials e.g. on Youtube. This one shows the approach I prefer: https://www.youtube.com/watch?v=fq8A95AQFYU. (Apply solder to one corner pad first; position IC with tweezers and solder into position. For each other pin, starting with the opposite corner, heat up pad and pin and then apply solder.)

Resistors and Capacitors

The same approach as for the ICs can be applied. This video shows how it's done for a 0603 resistor: https://www.youtube.com/watch?v=lrDyUj7ZfVI

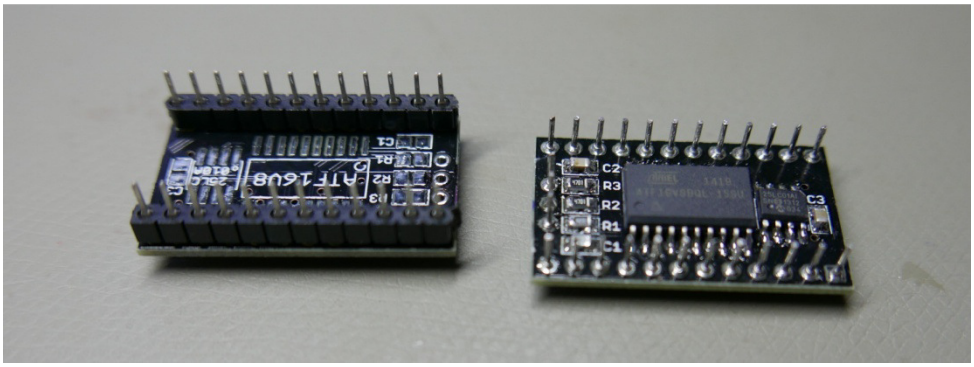




Pins

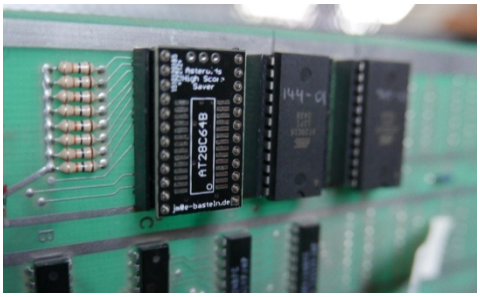
The pins which will connect the PCB to the ROM socket on the Asteroids board should be installed last; otherwise they would get in the way of installing the SMD components on the bottom of the PCB. There are several options for populating the pins – please review the pros and cons before soldering.

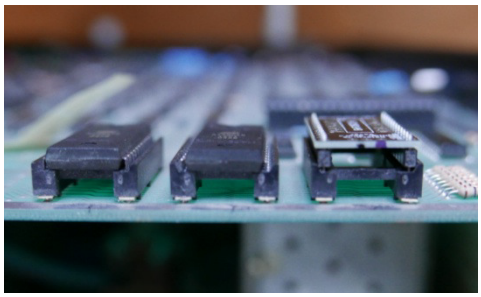
In any case, the pins need to stick out from the bottom of the PCB, i.e. the side with the GAL, serial EEPROM, and Rs and Cs!



Pin strips, 2.54mm pitch

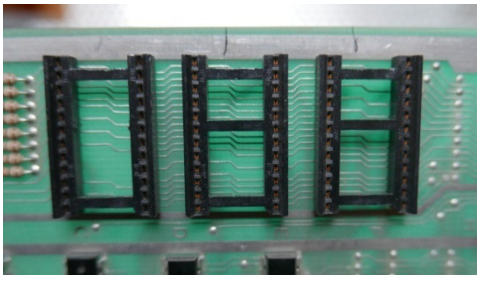
- Easiest to install. Snap off two strips of 10 pins each, solder into the board with the short pins. After soldering the first pin, check that the strips are fully inserted into the PCB and that the pins are at right angles to the board.
- Will add about 2mm of extra height for the plastic strips which sit between the IC socket and the PCB. Inconspicuous due to the black color, so I recommend this approach unless height is very critical.





Individual solder posts

- Lowest-profile installation of the PCB on the Asteroids board, by pushing the PCB all the way down into the EEPROM socket.
- Depending on the type of socket installed on the Asteroids board, you may need to clip out the socket's middle plastic bar to avoid a collision with the GAL chip.
- Difficult to obtain: For a good fit with the ROM socket, pins should be 0.5 to 0.6 mm diameter, and have a free length below the PCB of approx. 4 mm. I could not find any suitable pins from current suppliers; all new solder posts seem to be 1.0 or 1.3 mm in diameter. I happened to have some old stock Vero-brand pins of the right size.
- A bit more difficult to install: To solder these pins straight and with the correct spacing, insert all pins with their long ends into a precision (turned contact) DIP socket, then lower the PCB onto the short ends and solder.



Hand-cut wire

- If solder posts of the desired size are not available, cutting short wire pieces of suitable strength will of course also work.
- Like with the solder posts, use a DIP socket as a jig to align the wire segments for soldering. Wire segments can initially be cut a bit longer, then shortened to size after positioning the PCB onto the DIP socket (but before soldering).

Test and Initialization

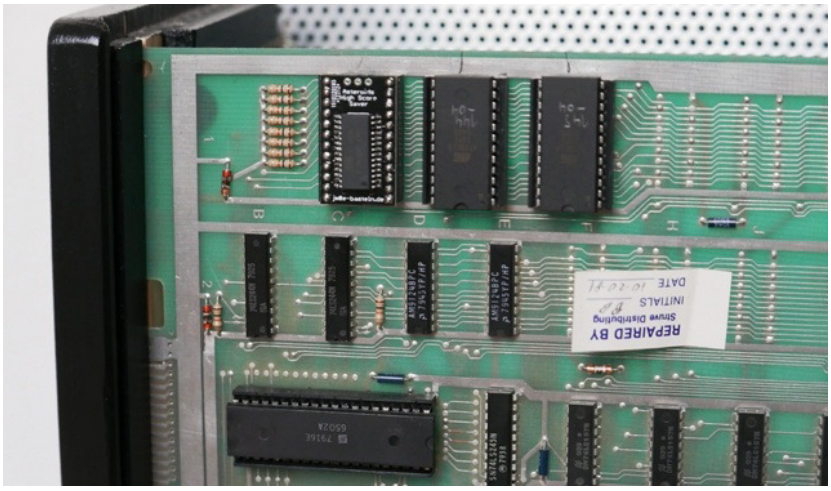
Visual Inspection

Before installing the PCB onto the Asteroids board, be sure to carefully examine all solder joints. Watch out especially for solder bridges between IC pins.

Installation

To install the High Score Saver, switch the Asteroids game off.

- Remove the program ROM for the $7800..$7FFF address range: Atari part 035143, which sits in position C1 on board revisions 02 to 04, and in position J2 on board revisions 05 and 06. (Note that the Atari schematics list a wrong ROM location for board revision 05 and 06!)
- Insert the High Score Saver instead. Pin 1 of the High Score Saver is indicated by a square solder pad, and by a dimple in the body of the AT28C64B EEPROM. Make sure this is oriented in the same direction as pin 1 of the other ROMs.



Initialization

Power up your Asteroids game. The screen should show a high score table right away, but with one or several somewhat distorted entries: a score of FFFF0, and a scrambled line instead of initials. This is normal behavior, and is due to the fact that the serial EEPROM (which stores the high score data) comes initialized to all $FF values from the factory.

To initialize the high score EEPROM for first-time use, follow the procedure for “Clearing High Scores” explained in the next section. This will clear all high score entries, and will also initialize the EEPROM write counter to zero.

Use

Gameplay

With the High Score Saver installed, game behavior should not change in any way. The only difference is that the high score table will persist when the game is reset, switched into service mode, or switched off and on again.

The high score table is retrieved from the EEPROM when the game restarts, and is written back to the EEPROM every time a new high score has been achieved and initials have been entered. Reading and writing is fast and will be unnoticeable to the player.

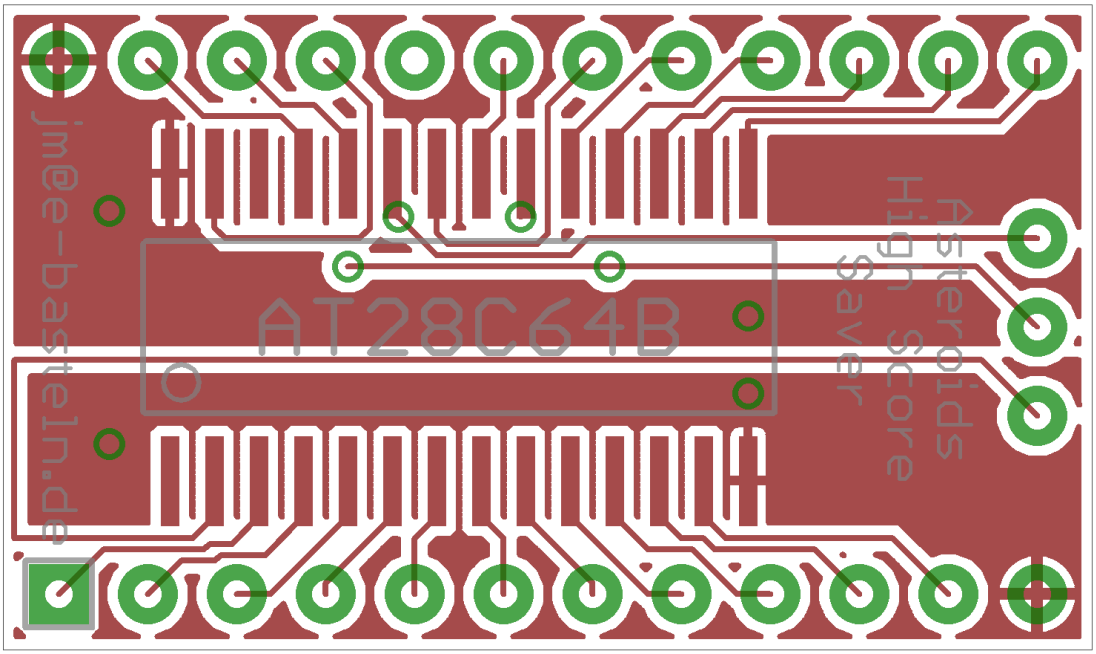
Clearing High Scores

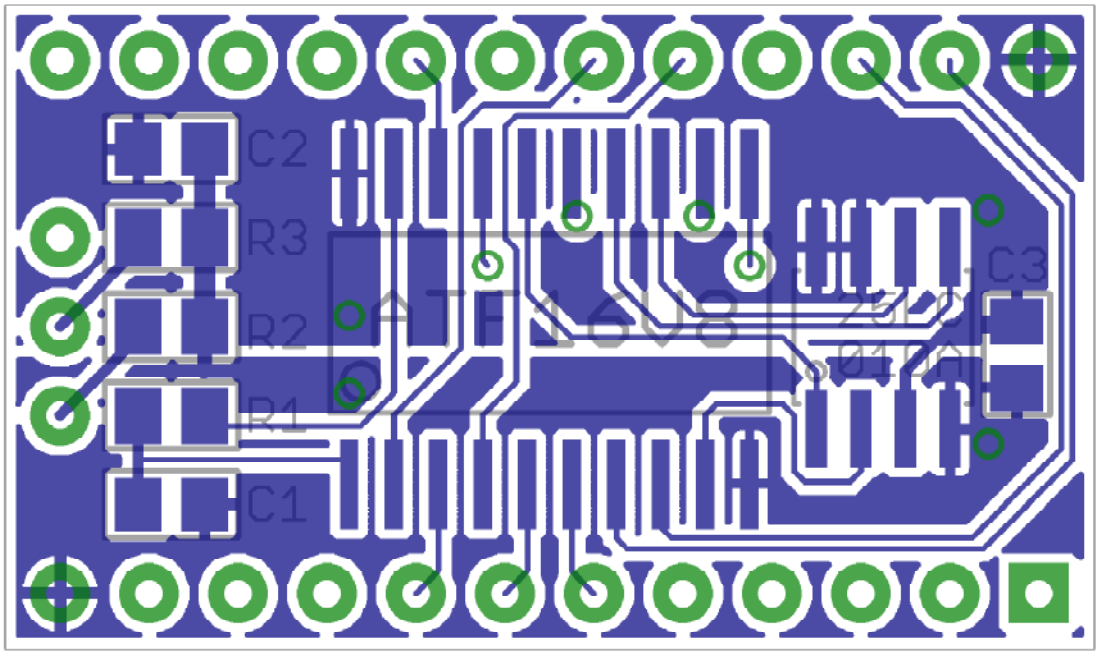
The high score table can be cleared from service mode. After initial assembly and installation of the High Score Saver PCB, please follow this procedure once to initialize the serial EEPROM. You can repeat the procedure later if you want to clear the high scores.

- Enter service mode by toggling the service switch.
- In the bottom of the screen, the service mode display should show “HSS REV X”, and an EEPROM write counter in the lower left.

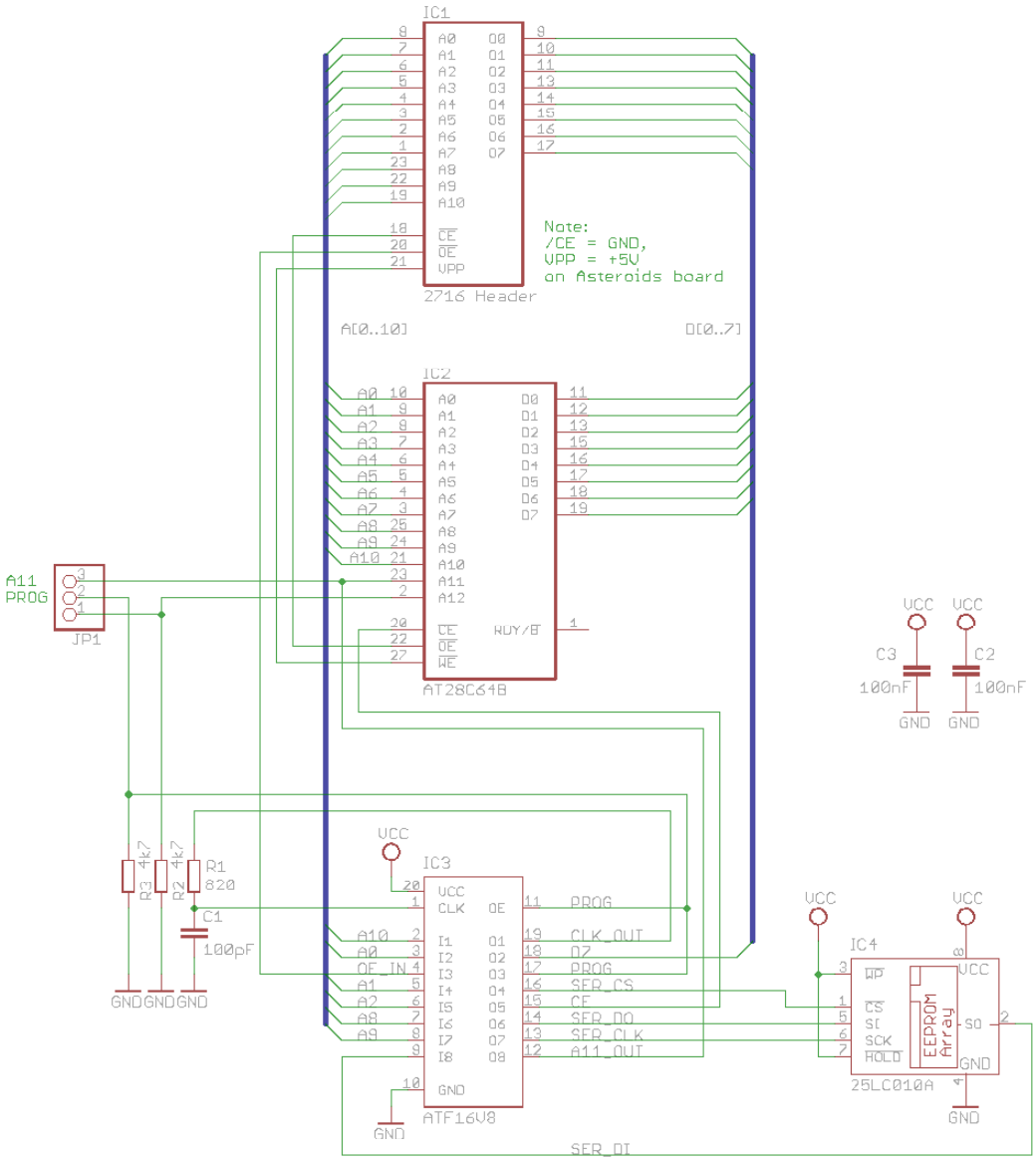
  The write counter is purely for information; it counts how many times a new high score has been stored in the EEPROM, or the EEPROM has been cleared. It is a four-digit hexadecimal counter, which will wrap around after reaching $FFFF (decimal 65536). While this wrap-around is unlikely to occur in a typical game play environment, the EEPROM itself is specified for many more write cycles – 1 million minimum according to the datasheet.
- Press and hold the following four buttons together: ROTATE LEFT, ROTATE RIGHT, FIRE, THRUST.
- As soon as all four buttons are pressed together, “CLEARED” should be displayed in the lower right. Also, the write counter in the lower left will be incremented by one.
- Leave service mode by toggling the service mode switch back.
- You will find the high score table cleared – indicated by the fact that Asteroids does *not* display it in attract mode anymore, until the next high score has been achieved and entered.

Layout and Schematic





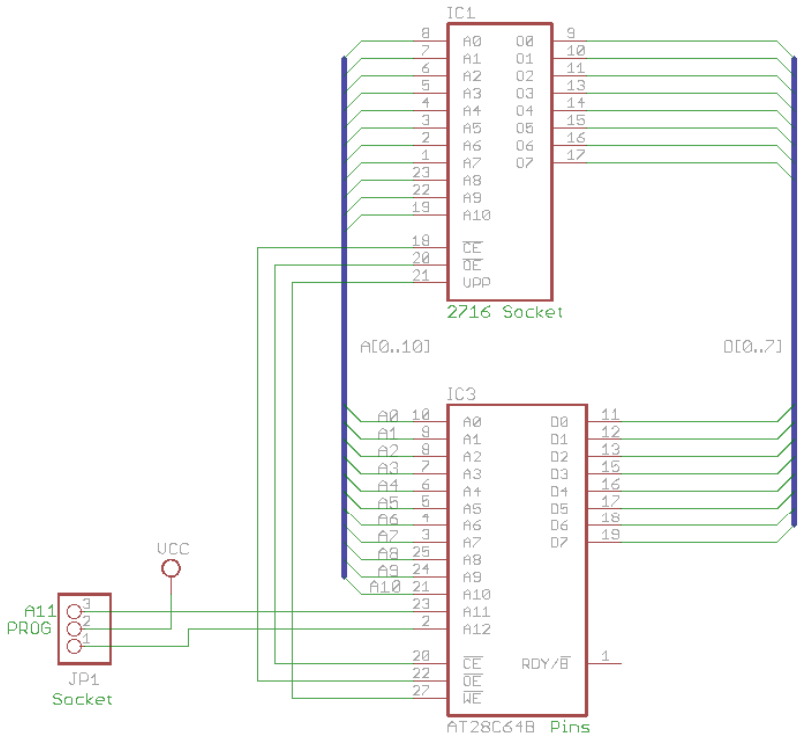
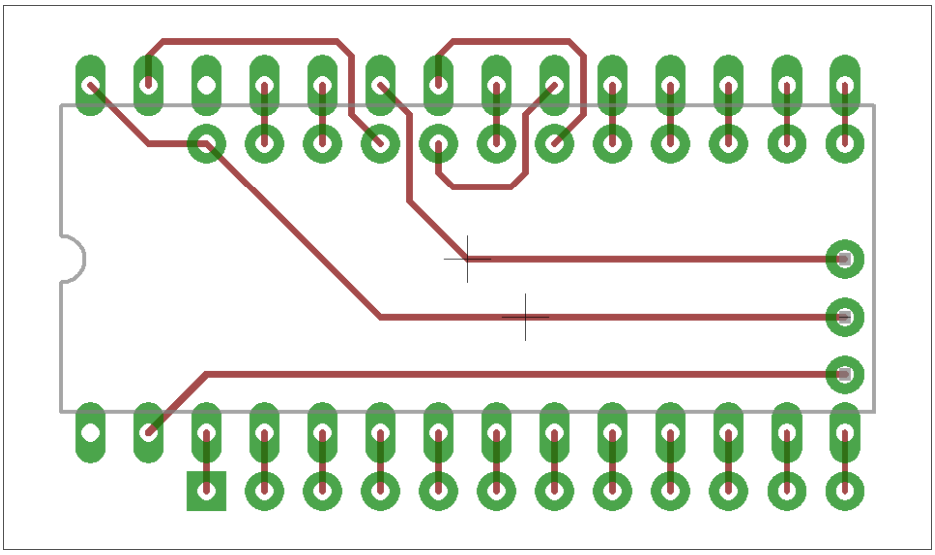
NAME: HSS_ROM	DATE: 06.12.2015 15:05:35	SHEET: 1/1
	Devices	



High Score Saver for Atari Asteroids
Jürgen Müller, juergen@e-basteln.de

Place into Socket for 035143 ROM ($7800..$7FFF).
Provides 2*2kB bank-switched parallel EEPROM for code
and 128*8bit serial EEPROM for high score storage.
Memory-mapped I/O in page $7E00..7EFF.

Programming Adapter

This is the optional programming adapter, needed if you want to reprogram the 28C64 EEPROM when it is installed on the PCB. DIP-24 socket and 3-pin extra socket for the High Score Saver PCB; DIP-28 pins for installation into an EEPROM programmer. Program in AT28C64B mode. (All 8 kByte can be programmed, but only the bottom 4 kByte are used in the circuit.)

Use the single-sided PCB layout below, or hand-wire on perfboard.