# EXCEL

## 52 PAGES of COLOURFUL, NOISY, ATARI FUN

**OUTSTANDING NEW GAMES**

SPELLBINDER

GUNFRIGHT
ULTIMATE
PLAY THE GAME
ATARI 8bit · 2017 · by Mariusz, José and Saul C

PANG

Fairlight
a prelude

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INTERVIEW

HARDWARE
PROJECTS
DIY CARTS

AND LOTS MORE!

After writing about DIY standard 8k and 16k EEPROM based cartridges in my previous column, I wanted to do a follow up article with building instructions for a more flexible and modern multi-cart design.

A multi-cart allows you to put lots of different games (and other software) on one cartridge and choose what to use from a built-in menu. Many different multi-carts have been made for our Atari 8-bits and most of them require lengthy programming of a (large) EEPROM every time you want to change the contents of the cartridge. Programming is usually done on the Atari with a SIO device as the source. This means these cartridges are not so useful as stand-alone devices and also makes them less than ideal for quickly trying out new software. With those issues in mind, a couple of years ago I designed the Ultimate Cart (1) an open-source multi-cart that uses an SD card for storage and is capable of emulating almost all types of cartridge ever released for the Atari 8-bit, including many other multi-carts. But the Ultimate cart requires some costly parts and advanced soldering techniques so it's not something that most people could easily build by themselves.

So for this article, I'm going to describe how to build my newest project – the UnoCart, a multi-cart I designed for readers of Excel magazine. It aims to be cheap (under £30) and easy to put together, yet provide a modern way to access a wide range of software (old and new) on an unmodified Atari XL or XE.

In many ways, the UnoCart is the little brother of the Ultimate Cart – it emulates a wide range of cartridges (up to 128k in size), can launch XEX files (executables) and ATR files (disk images), all from a micro SD card. It does all this using a single chip (hence the name of the project!) – a fast STM32407 ARM microcontroller running at 168MHz. This is fast enough to keep up with the 6502 bus and supply data to the Atari whenever it accesses the cartridge port. These microcontrollers are available ready to use on cheap development boards, so the only soldering involved in this project is making a simple breakout board so we can connect it up to the Atari's cartridge port.

You can read more about the capabilities of the UnoCart by downloading the User Guide which is available as a PDF on the project website (2).

## WHAT YOU NEED

**ST32F407 Discovery board.** There are two versions of this board – an older one (order code STM32F4DISCOVERY) and a newer version (order STM32F407G-DISC1). Either is suitable and costs about £16.

**Cartridge slot breakout board.** I've designed a PCB that slides into the cartridge slot, allowing the signals to be easily accessed with jumper wires. The PCB can be ordered from a PCB manufacturer using the breakout PCB file on the project website (2). For readers in the USA, the bits of the past website (3) offers a similar board for sale at $15.

I've got a number of these boards spare for readers of the magazine, so the cheapest option is to contact me (robin.edwards@gmail.com) to see if I've got any left. Cost would be £3 + P&P.

**2.54mm male header pins (x30).** If you don't have these already, they are cheaply (£1) available from eBay and all electronics suppliers, and need to be soldered to the cartridge breakout PCB (see below).

**Female to female jumper wires (x36).** You'll need 30 to hook up the cartridge port to the discovery board, and another 6 to hook up the SD card. Mine are 10cm long; a bit longer would have been easier (£2 on eBay).

**SD (or micro SD) card breakout board.** These are available cheaply on ebay and most online electronics hobbyist websites (£3-5). Since the discovery board is 3.3v (the same as SD cards) there is no need for a more expensive board with 5v conversion (though you can use those too). Something like (4) is ideal. I used a 5v regulated one (5) which I had in my components box.

Make sure the pins on the board you buy are labeled with the SPI connections –DI, DO, SCK (or CLK) & CS.

### Programming the Firmware
First you need to download the UnoCart firmware (a file with a .hex extension) from the project website (2) and save it.

To program this file to the board, download the ST-Link software (6) and install it. This should also install the ST-Link driver to your computer. With that done you can connect the Discovery board to your computer using a USB cable. Start the ST-Link software and select

Target/Connect. Then select Target/Program & Verify and select the .hex file you downloaded. When that completes, the UnoCart firmware will be flashed to your discovery board. Select Target/Disconnect and then unplug the USB cable – now you're ready to start wiring things up.

| Cartridge Breakout Board | Discovery Board | Notes |
|---|---|---|
| A0 to A12 | PD0 to PD12 | These are in two clusters on either side of the board. (A0->PD0, A1->PD1, ...) |
| D0 to D7 | PE8 to PE15 | On P1 (D0->PE8, D1->PE9, ...) |
| Phi | PC0 | On P1 |
| /S5 | PC1 | On P1 |
| /S4 | PC2 | On P1 |
| CTL | PC4 | On P1 |
| R/W | PC5 | On P1 |
| RD5 | PB2 | On P1 |
| RD4 | PB4 | On P2 |
| +5V | 5V | Use either of 5V pins on P2 |
| GND | GND | Use either of GND pins on P2 |

**Building**

First solder the male header pins to the breakout board PCB, by breaking the header strip up into 6 pieces with 5 pins. Insert these into the holes in the breakout board and solder them into place. Notice that the board is labelled S-A on one side and 1-15 on the other. The S-A side of the board will be facing upwards (XE) or towards you (XL) when inserted in an Atari.

For use on **XE** machines - you'll need to solder the pins so you will be able to attach the jumper wires to the top of the board (as seen in the picture).

On an **XL** machine, you may prefer to solder the pins the other way round, so the wires will be leading out towards the back of your machine rather than over the keyboard.

With that done, its time to wire up the 30 connections on the breakout board to the appropriate pins on the discovery board. The table above shows the connections you should make. Please check them carefully, since incorrect wiring may damage the discovery board, the Atari or both!

> **(1) You must disconnect the USB cable from the discovery board when plugging in the device to your Atari. The discovery board must be powered by the Atari via the cartridge slot only, or you will probably destroy the MMU chip on your Atari.**
>
> **(2) On an XL you should remove the cartridge slot flaps or otherwise prevent them touching the breakout board to prevent a short circuit.**

Now we can plug the device into the Atari and check our wiring so far - making sure that the USB cable is not plugged in (see notice above). If all has gone well, you should see the "error can't read SD card" screen (as shown on the right) when you power up the Atari with the board plugged in. If not, turn the power off quickly and find the mistake in your wiring.

Now we can hook up the SD card connections.

**First power up. We haven't wired up the SD card yet so the error is to be expected!**

**Connect as follows:**

| SD Card Breakout Board | Discovery Board | Notes |
|---|---|---|
| CS | PB5 | On P2 |
| SCK/CLK (Clock) | PB13 | On P1 |
| DO (Data out) | PB14 | On P1 |
| DI (Data in) | PB15 | On P1 |
| +3V | 3V | Use either 3V pin on P2 |
| GND (0V) | GND | Use either GND pins on P2 |

Assembly is now complete – you should be able to plug the board into your Atari, power up and see a list of all the loadable files and directories on the SD card. Use the cursor keys and return to select a XEX, ROM, CAR or ATR file and enjoy!

If everything is working, its now worth downloading the full instruction manual for the UnoCart from the project website.

Troubleshooting tip - Some SD cards fail to initialize without a pull-up resistor on DO. Either try a different SD card or add this pull up by connecting any resistor in the range of 10k to 100k (I used 47k) between DO and 3V.  You can see I have soldered this directly onto the SD card breakout board in the picture.

## Links

(1)  github.com/robinhedwards/UltimateCart/
(2)  github.com/robinhedwards/UnoCart/
(3)  www.bitsofthepast.com
(4)  www.hobbytronics.co.uk/microsd-breakout
(5)  www.hobbytronics.co.uk/microsd-card-regulated-v2
(6)  www.st.com/en/embedded-software/stsw-link004.html



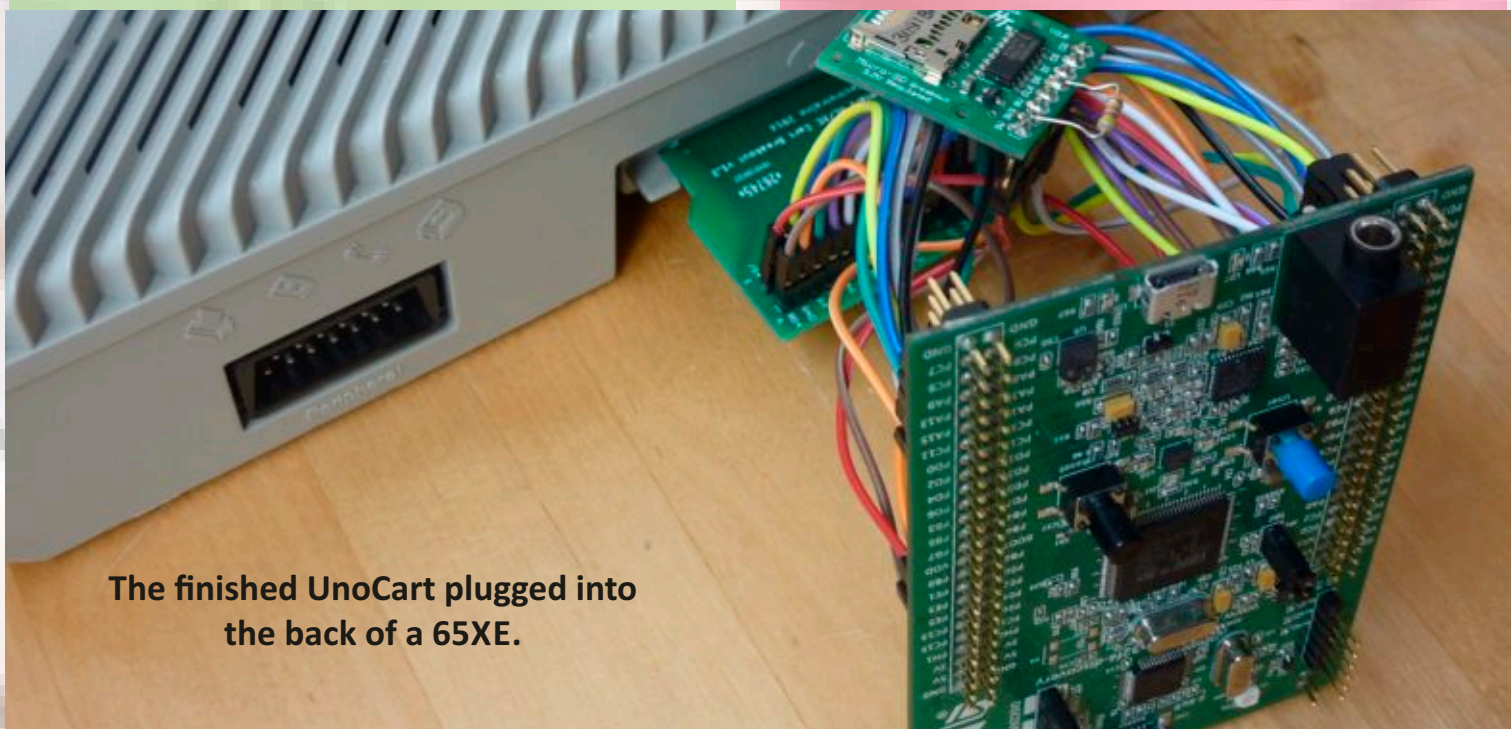The UnoCart menu when everything is working.
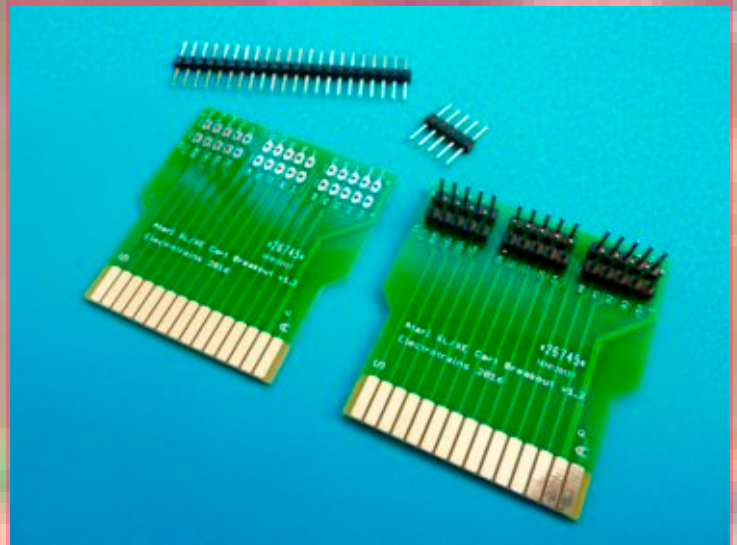


Cartridge slot breakout PCB and header strip (left) and assembled version for use on an Atari XE (right).
The cheapest way to get one is to contact the author and see if he has any spares!



The STM32F407 DISCOVERY board (older version). A lot of power for £16!



The finished UnoCart plugged into the back of a 65XE.