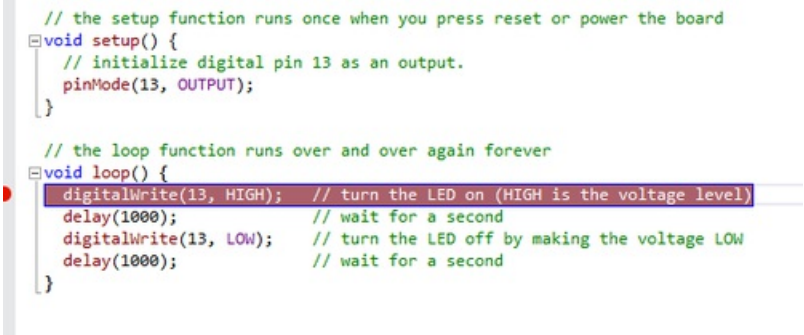
adafruit learning system

Proper Debugging of ATSAMD21 Processors

Created by lady ada



Last updated on 2018-03-28 04:35:51 PM UTC

Guide Contents

Overview

```
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin 13 as an output.
  pinMode(13, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(13, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);              // wait for a second
}
```

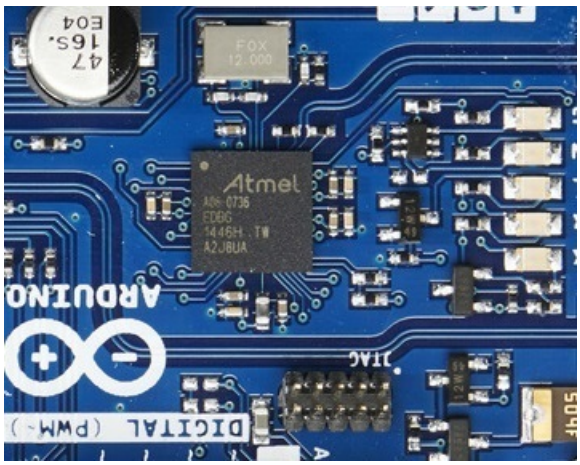
Chances are if you're programming firmware on a microcontroller you've had to do some 'fun' debugging. Button presses, interrupts, small memory spaces...it can make debugging quite a challenge! A lot of beginners lean on tried-and-true (if a little frustrating) printf statments or toggling GPIO's with LEDs on them. And don't get me wrong, those techniques work pretty well. But if you come from a software background you're probably used to really nice debugging setups, often built into the IDE

Of course its a ton easier to debug software when the computer is running both software and development platform. It's a lot tougher when the processor is physically separated, with its own memory, clocks, peripherals, and its not even of the same *processor family!*

No worries though, there's a full industry set up to create programming/debug dongles and adapters!One of our favorites is SEGGER's J-Link family. They're not *cheap* but they do support a vast number of chips.

Atmel also has it's own debugger chip, the EDBG (apparently its a AT32UC3A4256 programmed with Atmels proprietary firmware)

This chip comes on every Arduino Zero and is used to both program and debug firmware



You may be wondering "OK so how do I actually do said debugging?" Well you've come to the right place because we're gonna show you how. In this guide we'll show how to debug the ATSAMD21 family (specifically the ATSAMD21G18) which is in the Arduino Zero and Feather M0 family, by using the EDBG or J-Link.

Install Software

Before you begin you will need some software. Here's what we're using:

Arduino IDE

As of this writing, 1.6.7 is the latest so we're using that. We also installed the Arduino SAMD support and/or Adafruit SAMD support (for Feather M0)

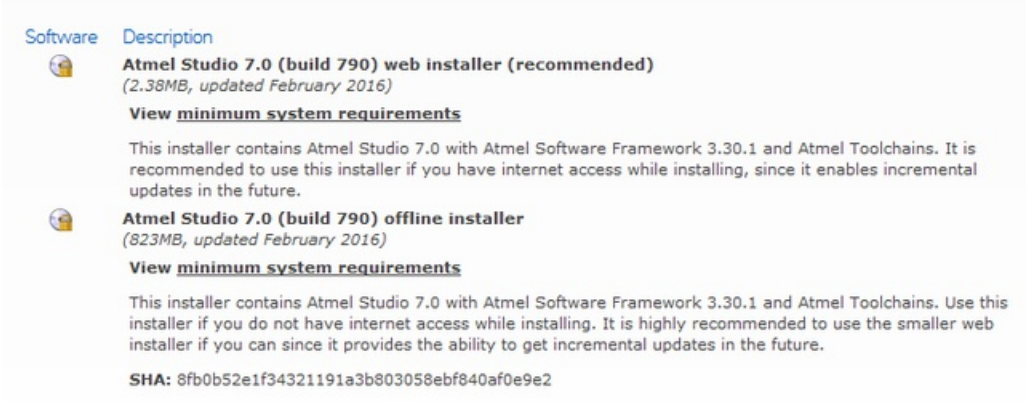
Make sure you also have drivers set up for the board you're using, and get a sketch working and uploaded to the board. That means you have the IDE and package set up, which is something you want done **before** you continue

J-Link Software

If you're using a J-Link, install all software and drivers for it and run the J-Link commander to make sure you update the firmware, new firmware is constantly being released so best to update your 'Link!

Atmel Studio 7

Here's where the Mac and Linux people will be sad. This is the IDE software that can do step&memory debugging and its only for Windows. Also you have to make an account on Atmel's site, download it from here



Make sure you have the latest version, we used **build 790**

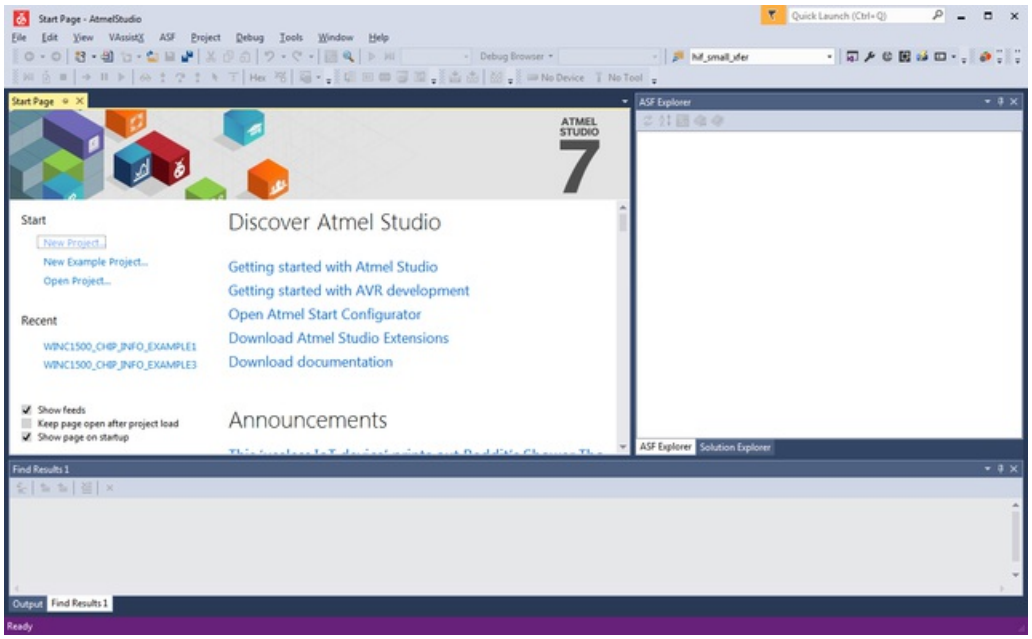
Let's go!

> Note that by uploading a debug sketch you will blow away the bootloader on your Arduino Zero or Feather M0, see the next section for re-loading it!

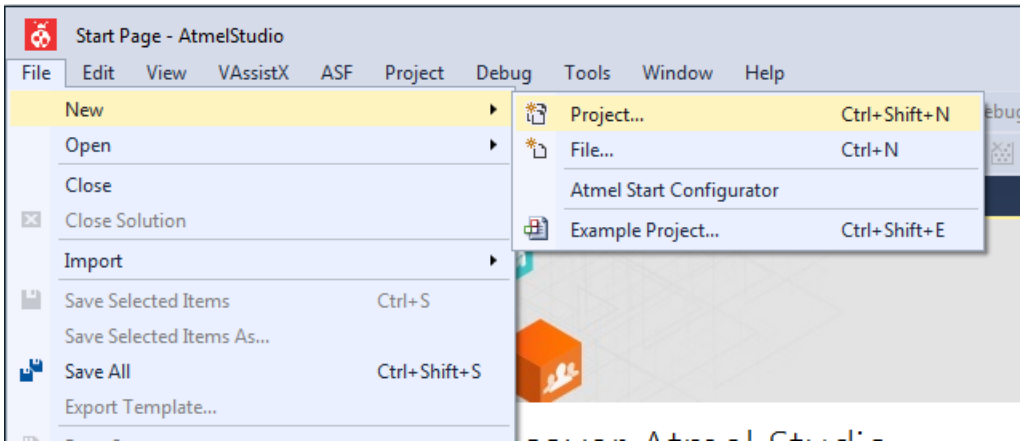
OK now that we have all that software, the rest isn't too tough!

Load an Arduino Sketch in Atmel Studio 7

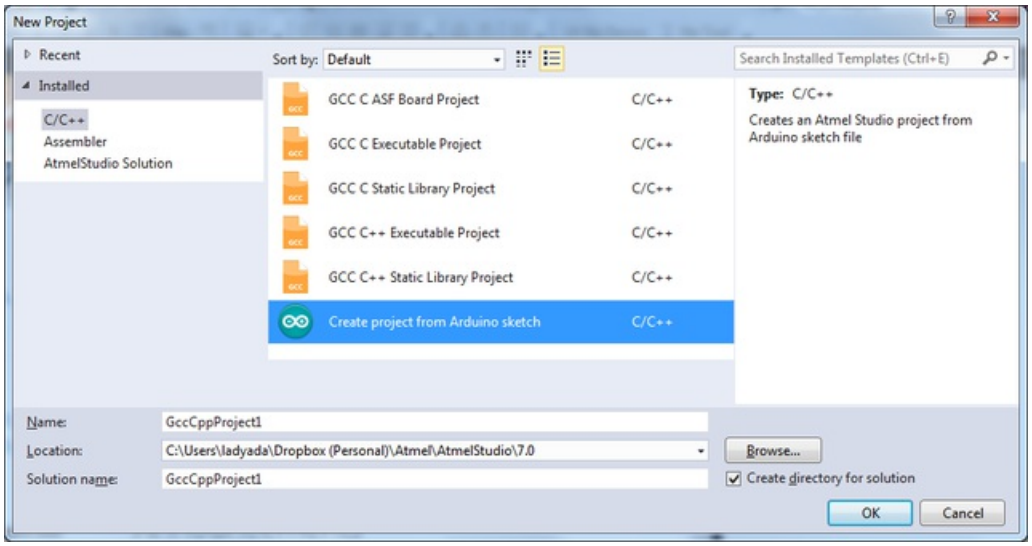
Start by launching Atmel Studio 7



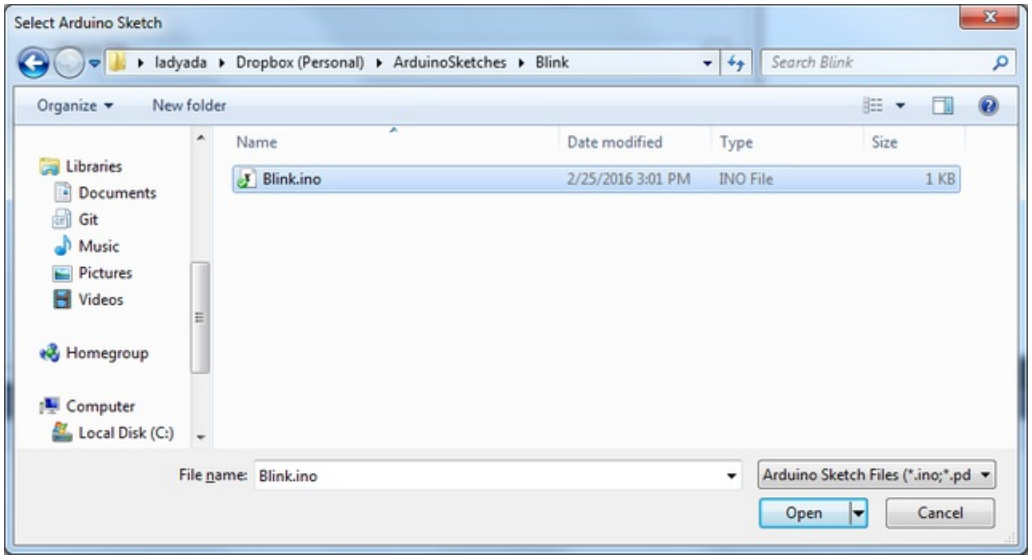
Create a new Project



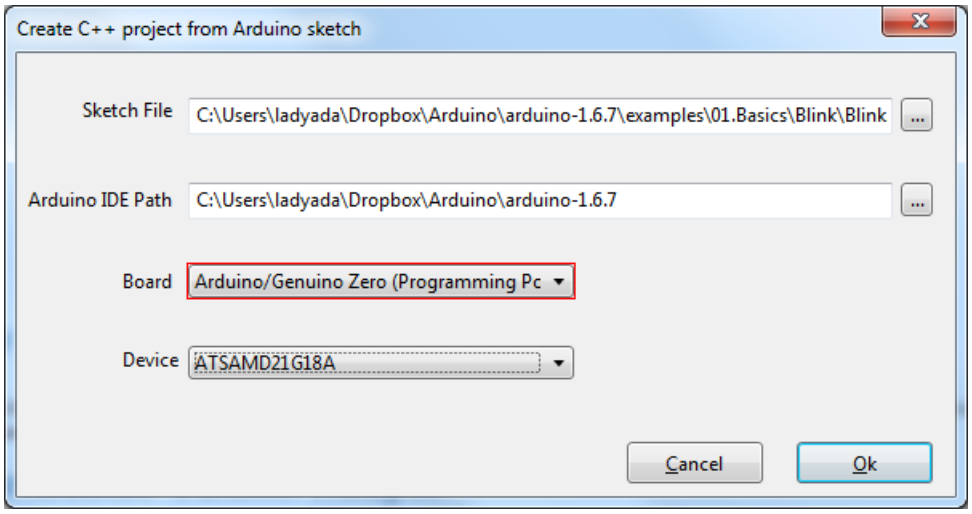
And select **Create project from Arduino sketch**



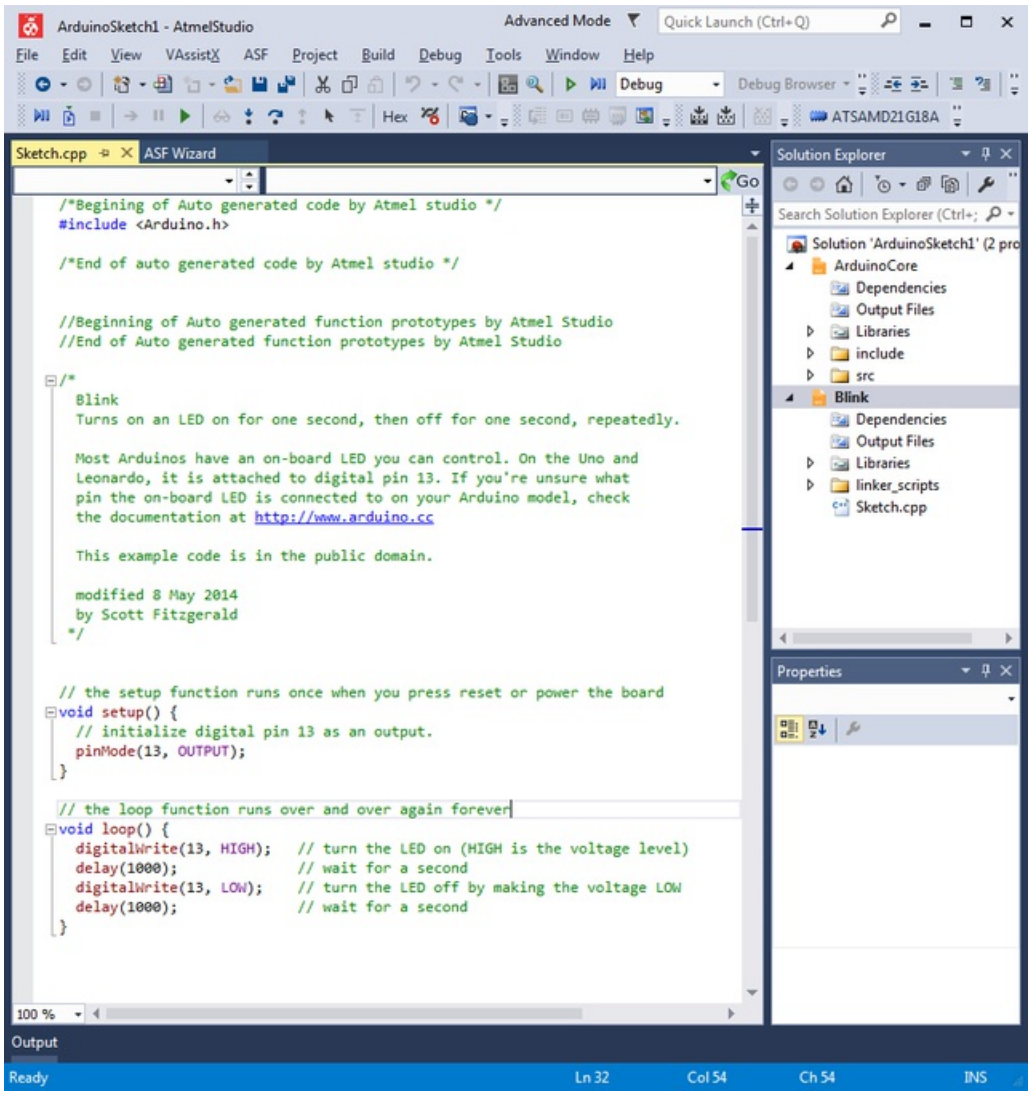
Navigate to your arduino sketchfolder and select the sketch. I recommend starting with the easy-to-understand **Blink**



Also select the Arduino IDE location if necessary. For **Board** go with **Arduino/Genuino Zero (Programming Port)** and under Device, **ATSAMD21G18A**



You'll see the following, where the sketch is in a window, you can edit the code here if you like. For now just leave it as is.

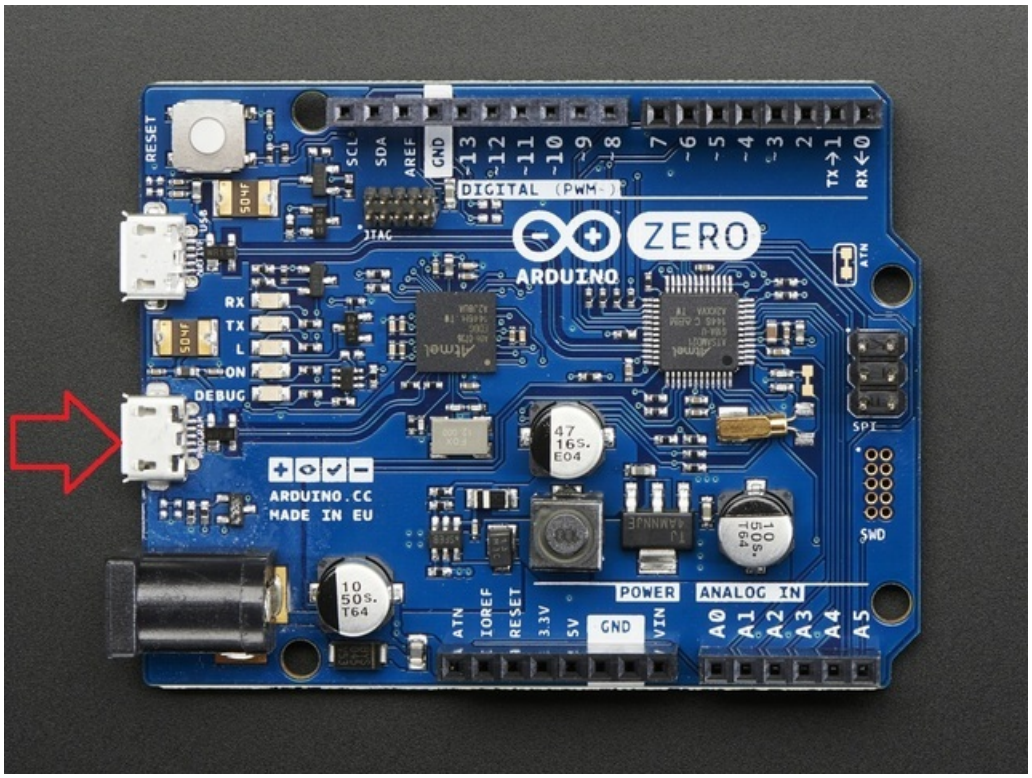


Set Up and Check Interface

OK next up we'll attach the chip & debugger. You have two options:

Arduino Zero Debug port

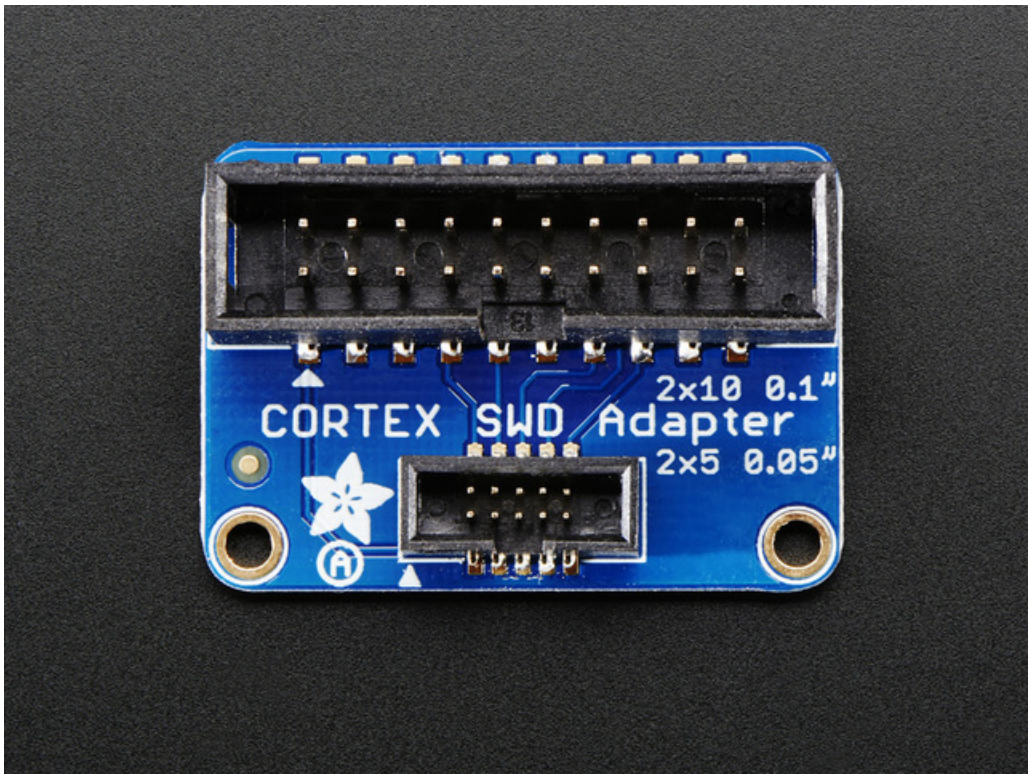
This is super easy, just connect a USB micro B cable to your Arduino Zero



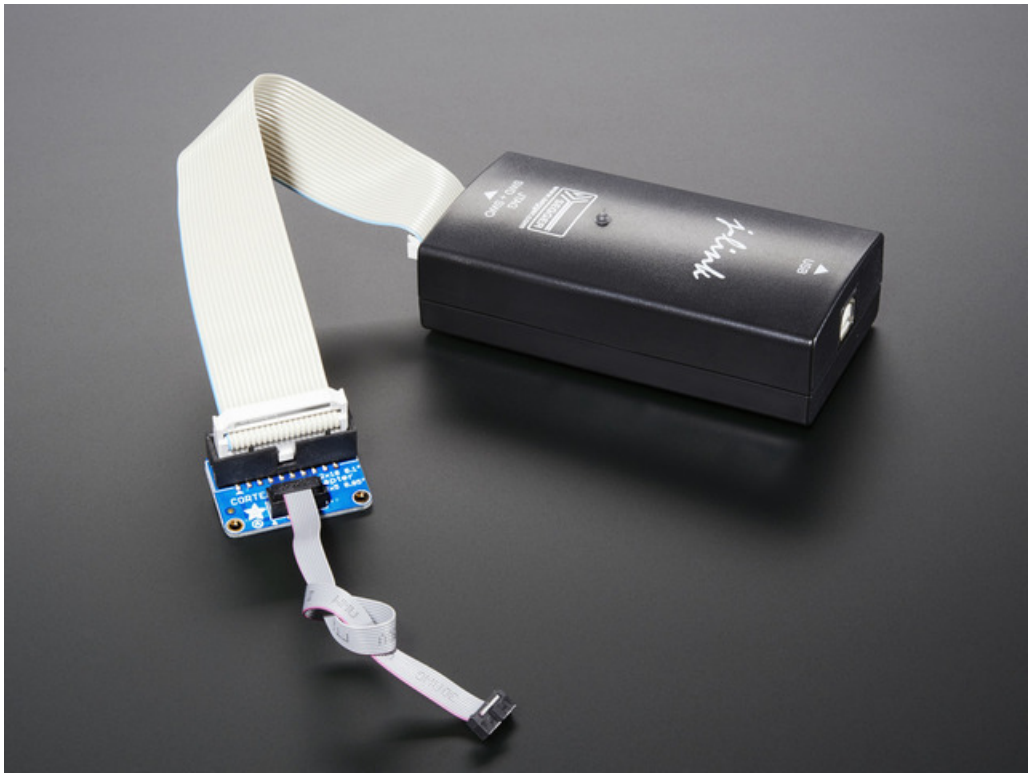
Make sure you're plugged into the DEBUG port not the 'native' port

J-Link to SWD

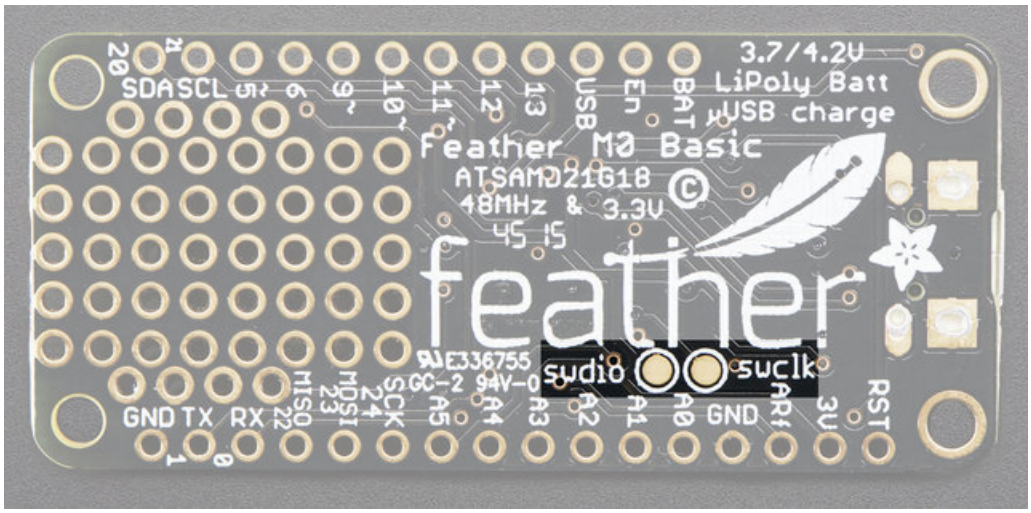
If you have a board without an EDBG chip on it, you can still debug, but you'll need a helper such as a J-Link.We like using this handy adapter board



To get the large J-Link cable do the 'classic' 2x5 SWD cable connector



If you are debugging a board that doesn't even have an SWD connector on it, you may need to solder to the SWD pads



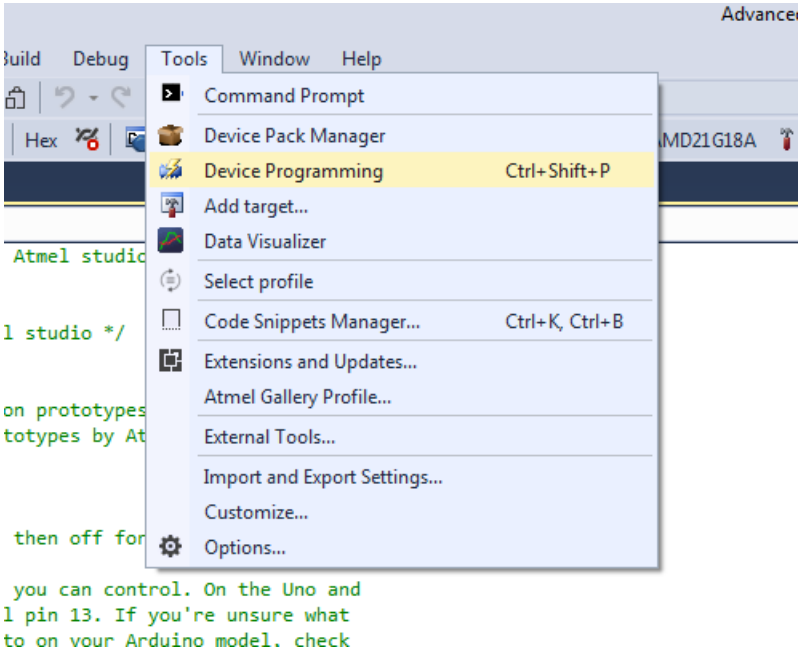
You need to connect the following to the J-Link:

- **Vref** / **Vtarget** - Logic voltage of the chip, in this case 3.3V
- **GND** to common ground
- **SWDIO** to **SWDIO**
- **SWCLK** to **SWCLK**

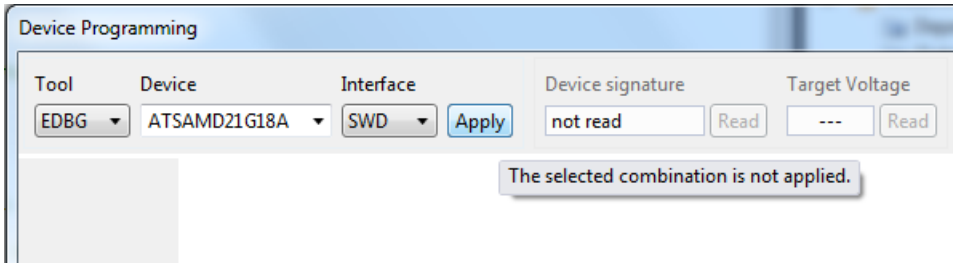
I haven't found I need to connect the chip's RESET line

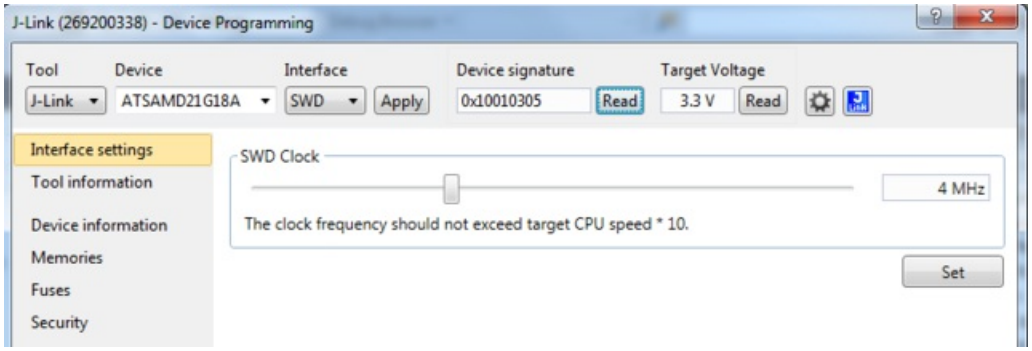
Identify Interface

OK now you have your debugger plugged in, its good to check that it works, select **Device Programming**



Under **Tool** make sure you can select **EDBG** or **J-Link**

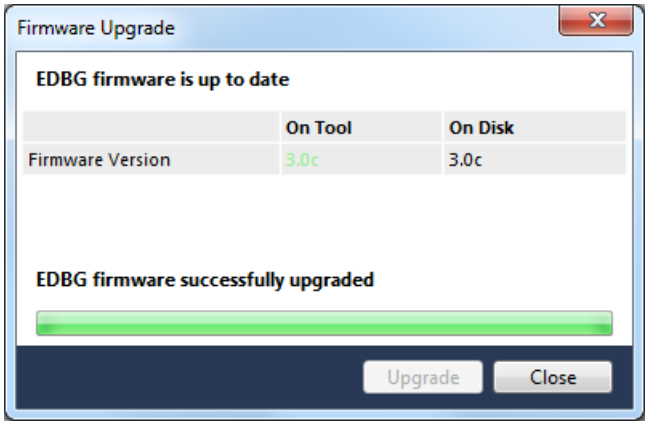




Select **ATSAMD21G18A** as the device, **SWD** as the interface and hit **Apply**

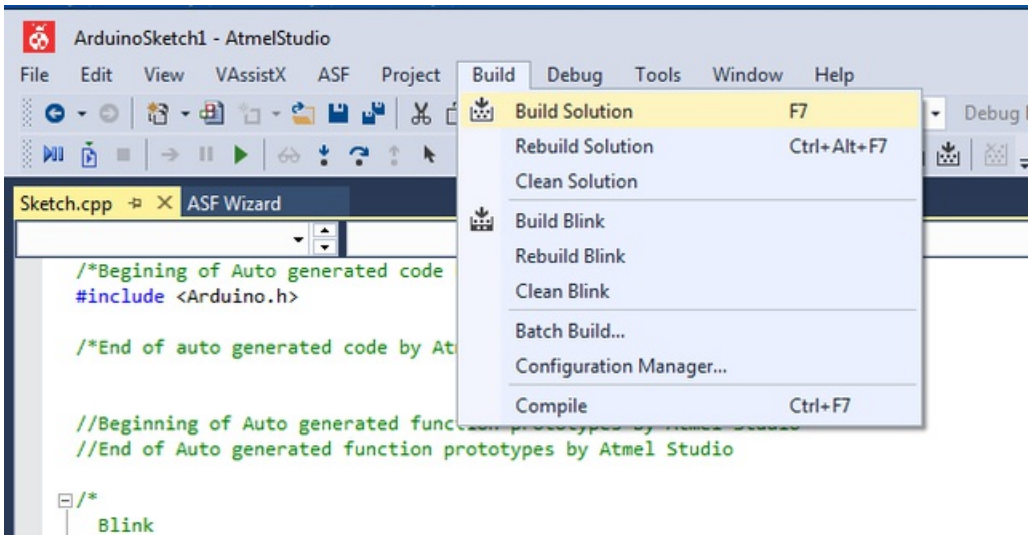
You can then **Read** the Device Signature. Make sure this all works before you continue!

If you are asked to update the J-Link or EDBG firmware, its OK to do so now.

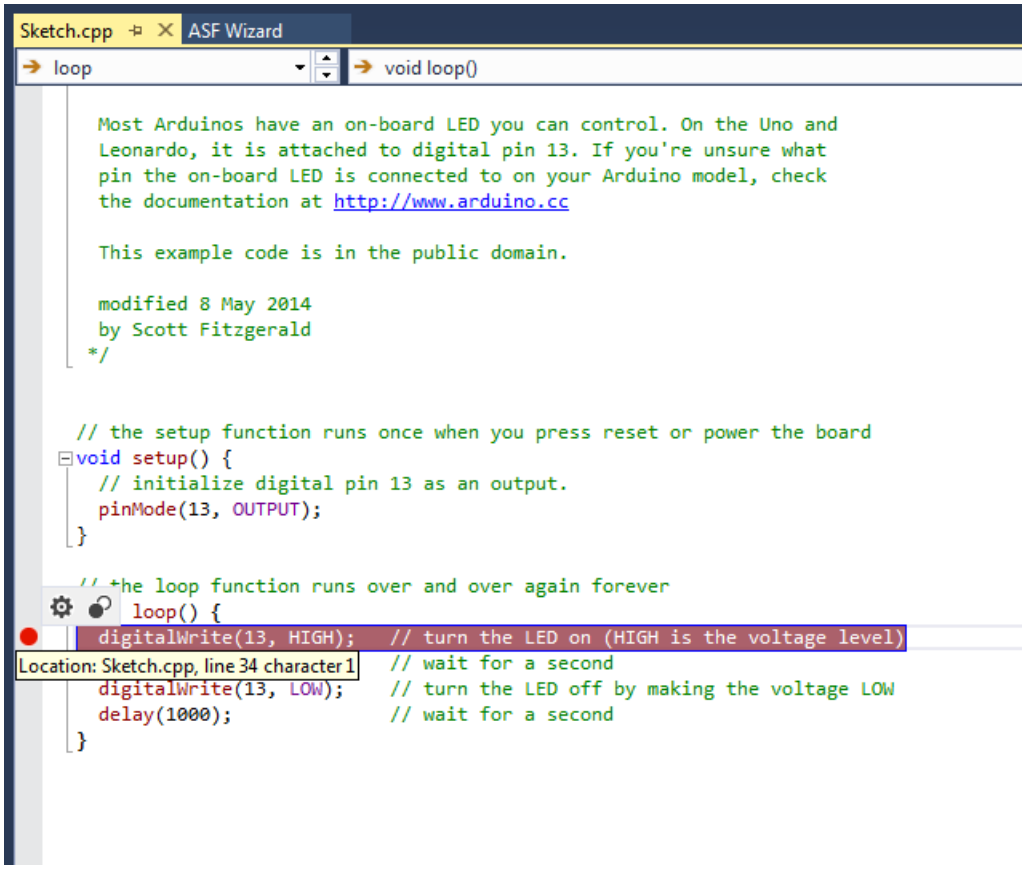


Build & Start Debugging

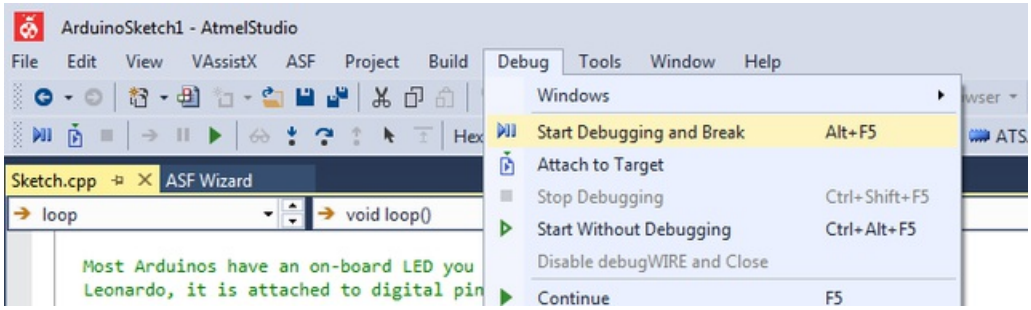
OK close out the modal programming window, we dont need it for now. **Build** the program



Add a **Break** by clicking on the first **DigitalWrite** function call, you'll see a red dot

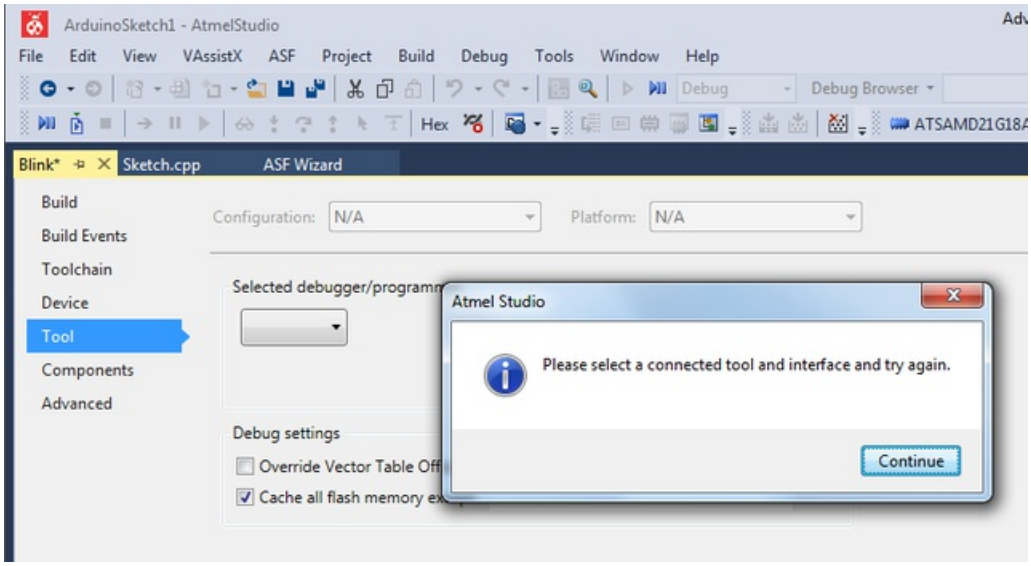


Now run **Start Debugging and Break**

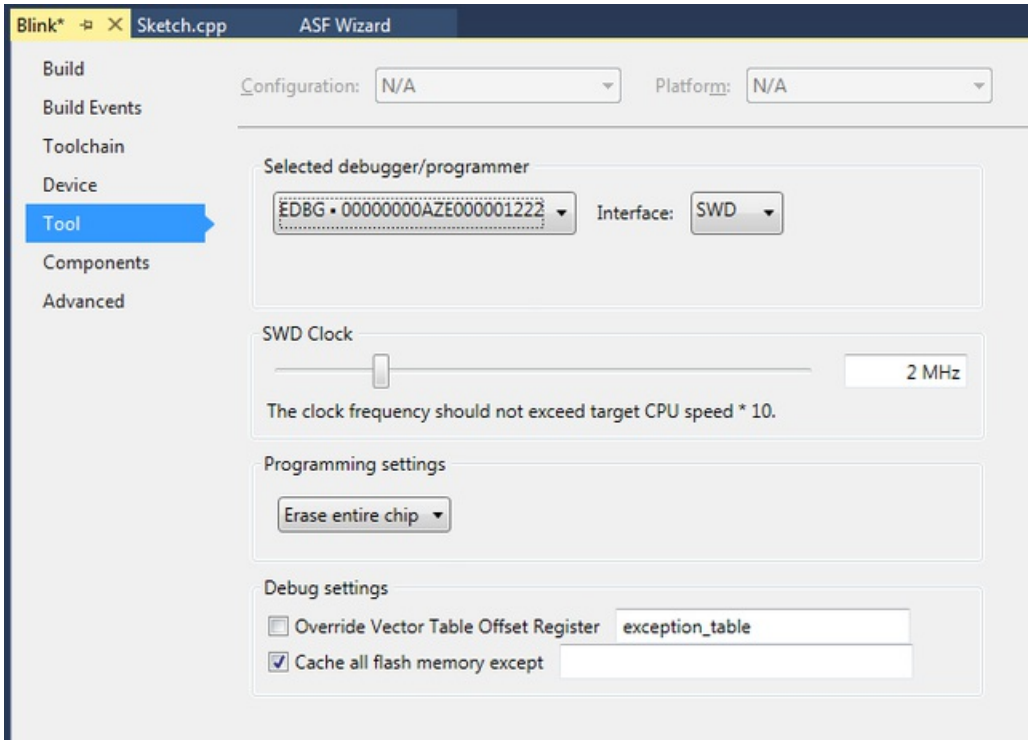


Note that by uploading a debug sketch you will blow away the bootloader on your Arduino Zero or Feather M0, see the next section for re-loading it!

You'll get prompted to select a debugging tool

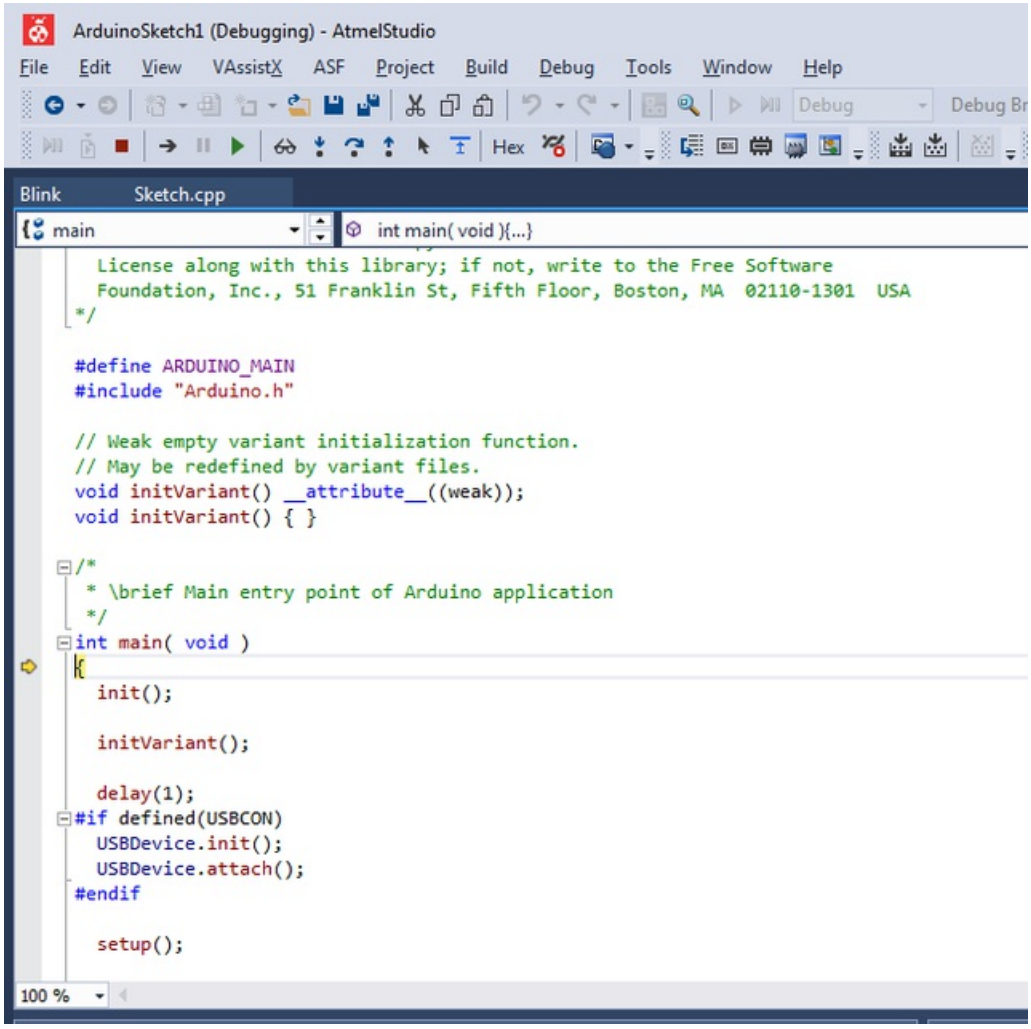


Go thru what you did before, selecting the programmer and processor

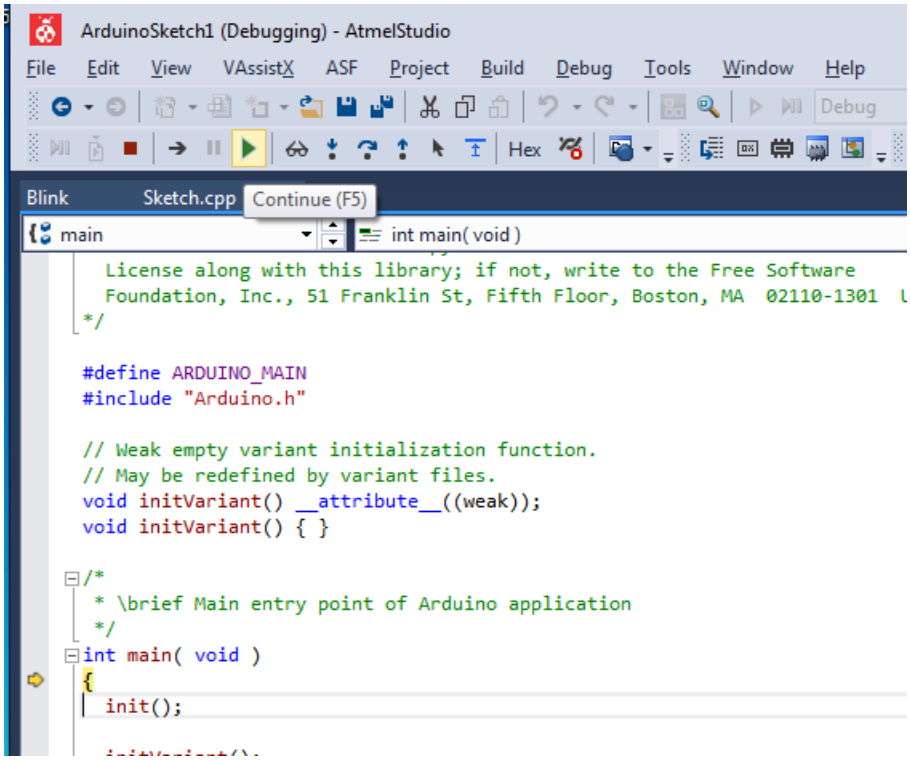


Once done go back and re-run **Start Debugging**

You'll end up in a strange code, labeled **int main(void)** { this is the main entry point to the sketch. Normally this part is never seen, it's what sets up the Arduino before you get to the **setup** section of the sketch!

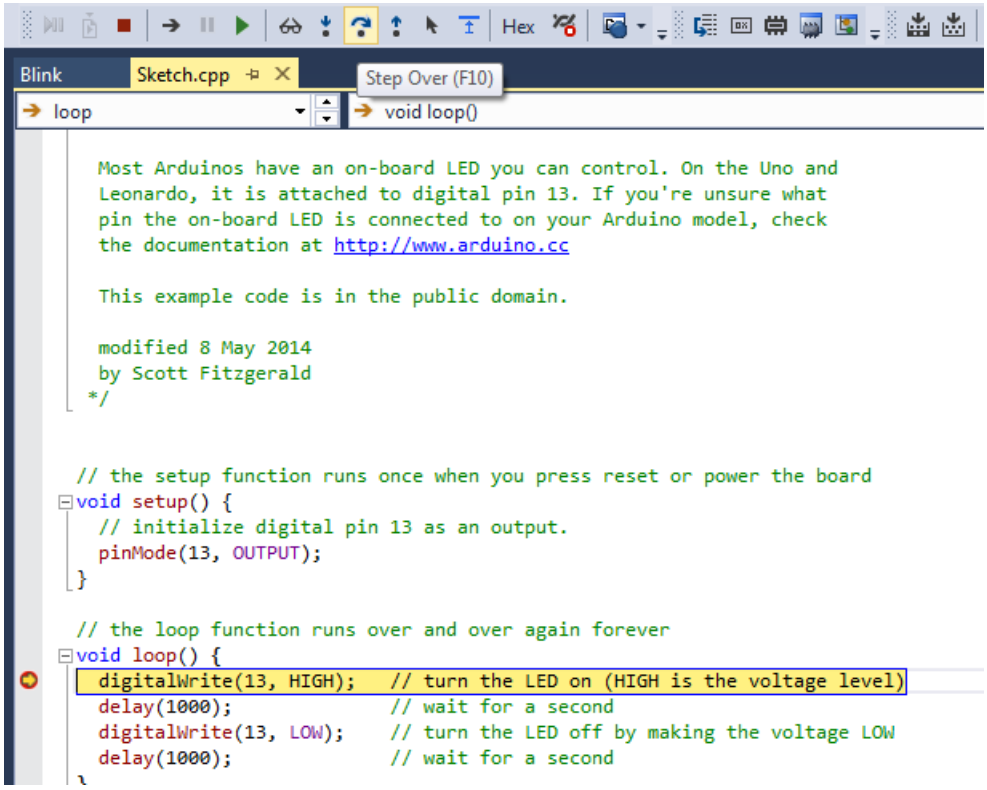


Select **Continue** to skip ahead to your stopping point

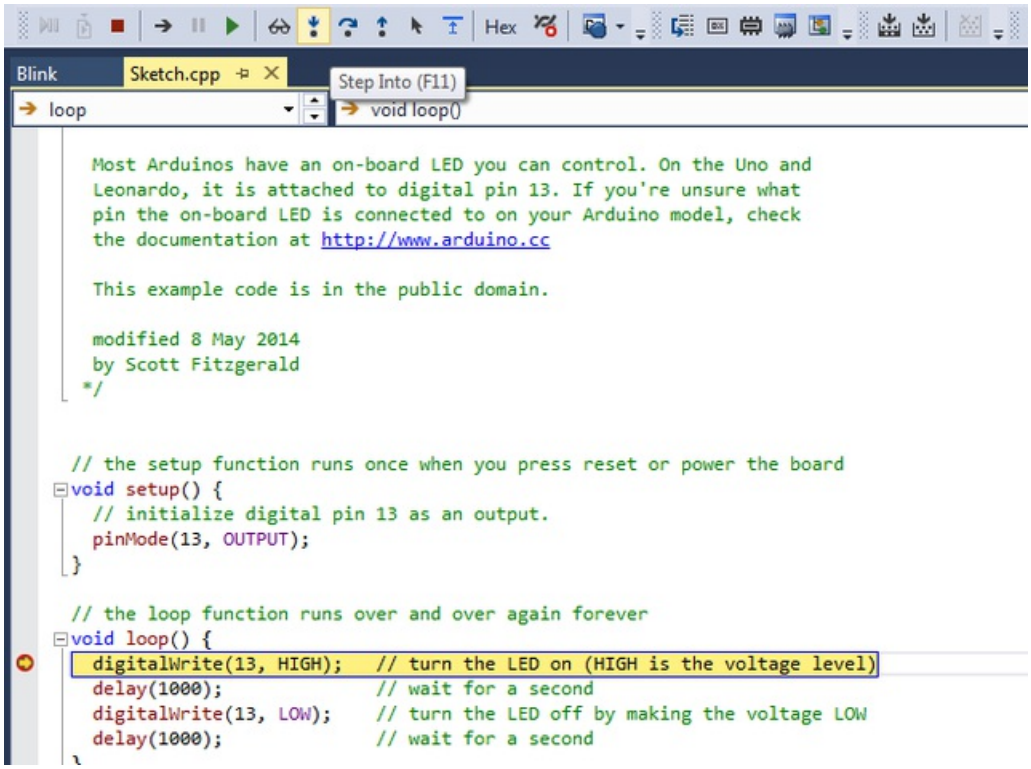


Now you'll end up at that **DigitalWrite** with the red dot. Note that you stop right *before* this gets run.

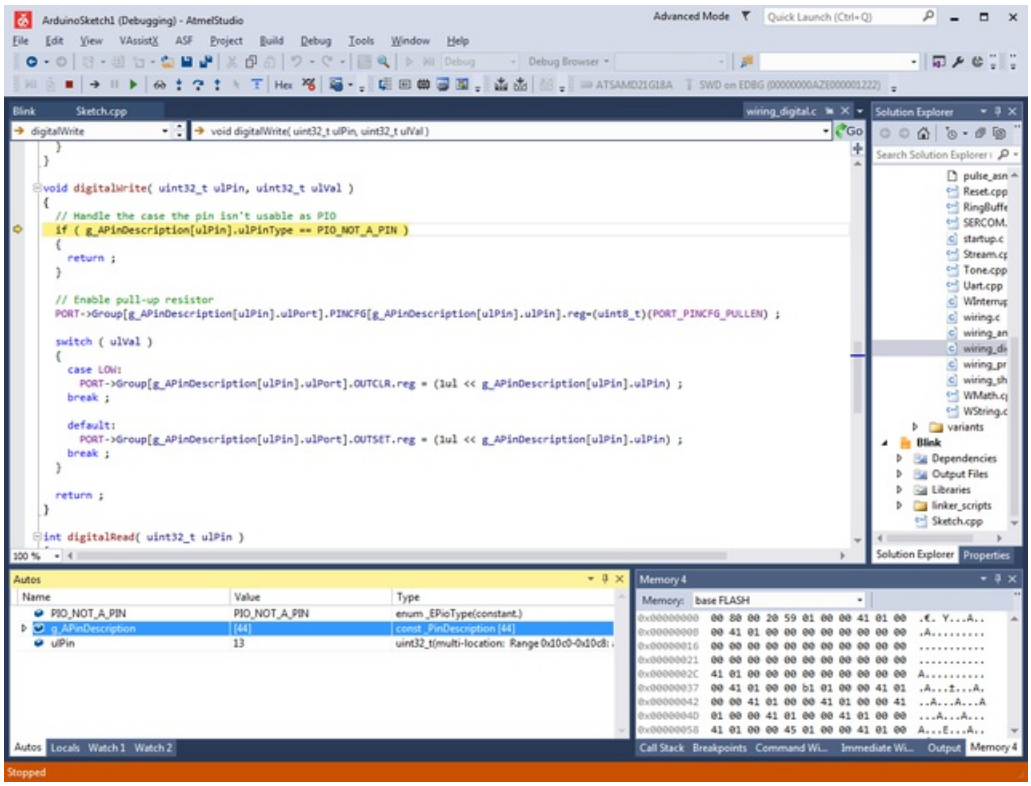
Now select **Step Over** to execute that line. Since you're in step-debugging mode you'll have to **Step** each function call you want to run. If you just want to continue running the code without any delays or steps, click on **Continue** like you did before



You can also dig deeper into a function with **Step Into**



This will let you go *into* the function call, to see what goes on inside. You can then continue to step over, step in or step out (complete the function)



You can also see variable names below, and the entirety of memory. Since this is just a basic tutorial we wont go into

the vast depths of debugging, stack traces, and memory twiddling!

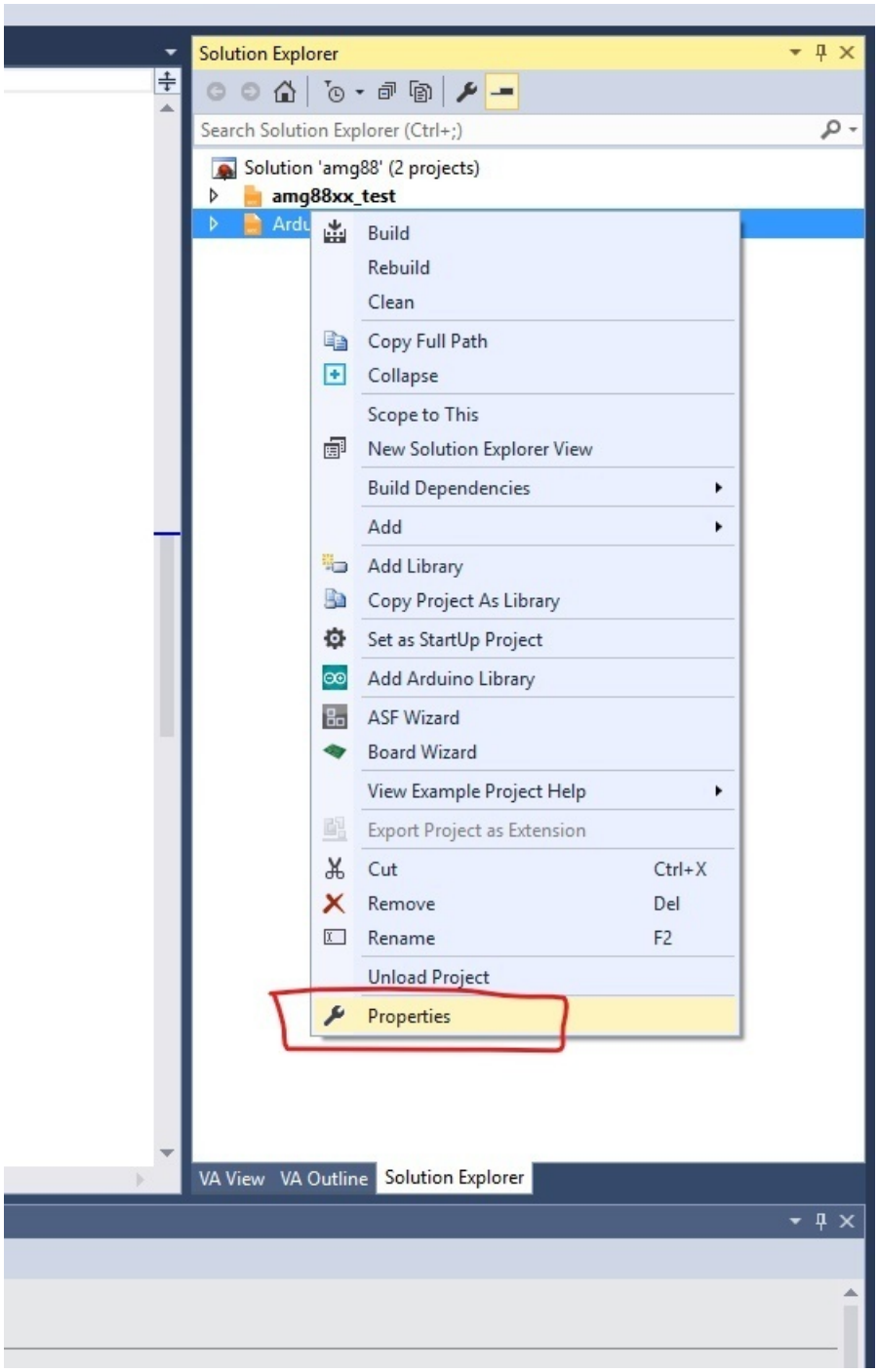
There's a ton more details on the Atmel Studio documentation page

Paths and Optimizations

C and C++ compilers make your code better when they compile it! This is great, but when we are trying to debug our code we don't want anything to change it.

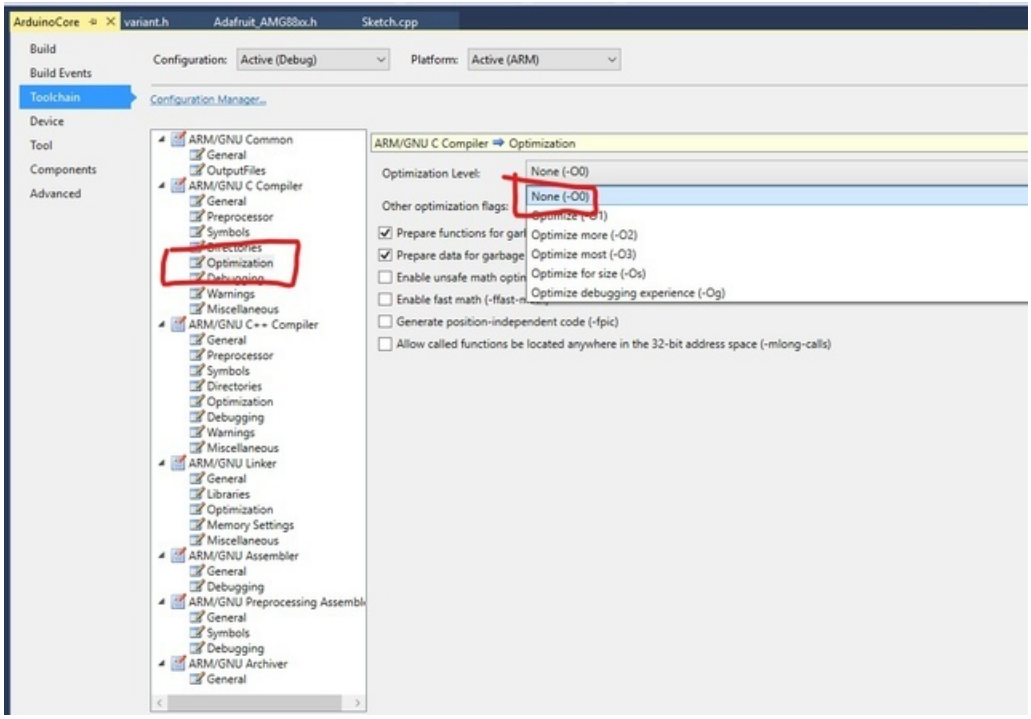
If you try to use the debugger and you see that it doesn't move from one line to the next as you would expect, this is because you have compiler optimizations turned on.

to turn them off, right click on the **ArduinoCore** project in the **Solution Explorer** pane, and click **properties**.

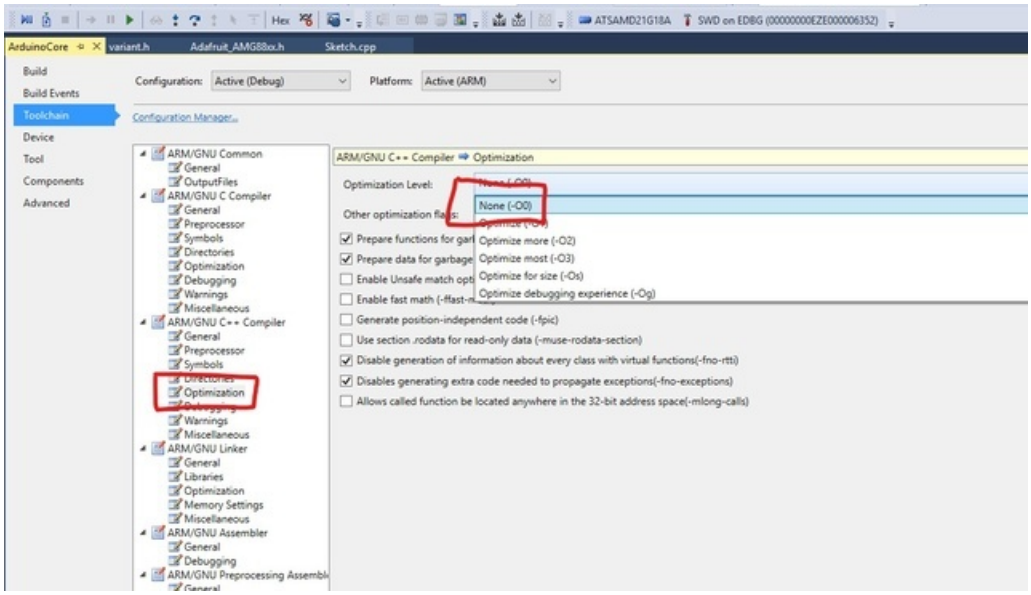


Then under **Toolchain**, go to the **ARM/GNU C Compiler** heading and click **Optimization**. Set **Optimization Level**

to **None (-O0)**.



Then do the same thing under the **ARM/GNU C++ Compiler** heading.



Then save your project.

Now, repeat the above steps to turn off compiler optimizations for the other project (whatever you have named your sketch) in the solution explorer.

> There should be two projects in the Solution Explorer pane. ArduinoCore, and whatever you have named your sketch. Make sure you have done the above steps to turn off compiler optimizations on both projects in the solution explorer pane.

Correcting Paths to Necessary Files

Current versions of Arduino have changed the location of the CMSIS core files that are necessary to compile projects.

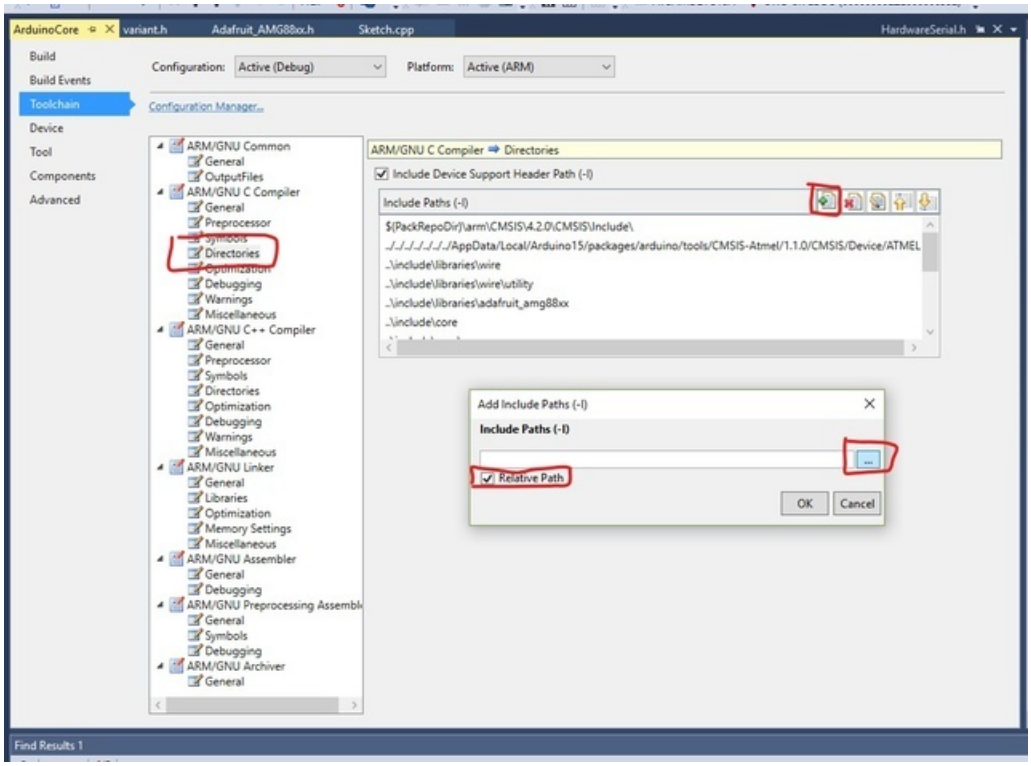
We can fix these paths by going back to the **Properties** pane (by right clicking on the project in **Solution Explorer** and selecting **Properties** as we did before) and under **ARM/GNU C Compiler** select **Directories** and add the new path to the CMSIS core files to the Include Paths section.

This can be done by clicking the green plus button, and then finding the folder by clicking the **...** button in the window that pops up.

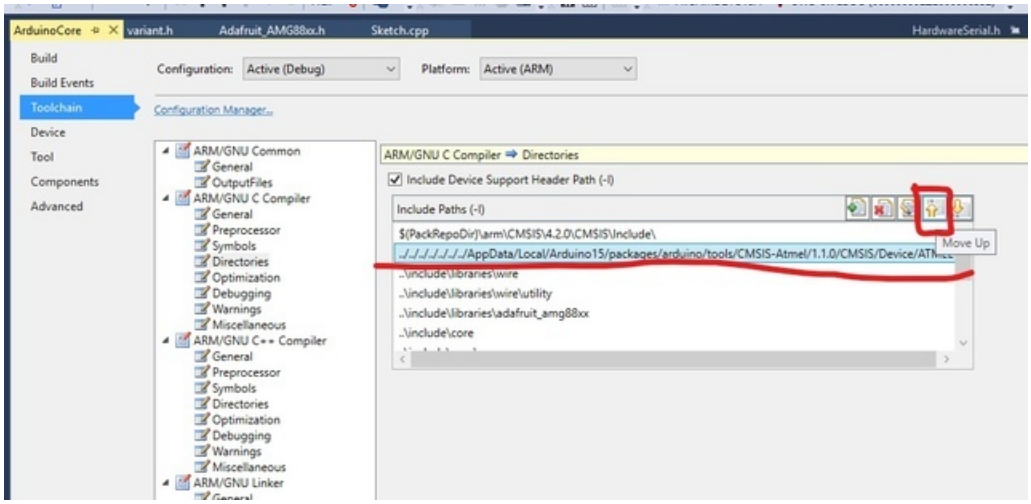
Leave the **Relative Path** box checked.

The current location of the CMSIS core as of the writing of this guide is:

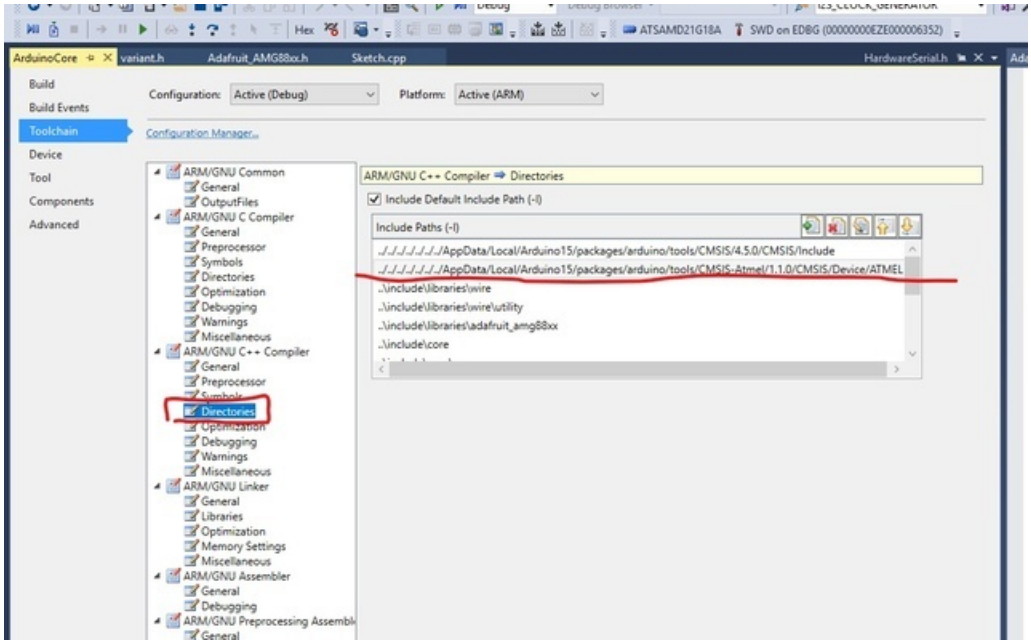
C:\Users\YourNameHere\AppData\Local\Arduino15\packages\arduino\tools\CMSIS-Atmel\1.1.0\CMSIS\Device\ATMEL



Then select the path you just added in the list and click the yellow up arrow icon to move it to the top of the list.



Now repeat those same steps in the **Directories** pane under the **ARM/GNU C++ Compiler** section.



Do these steps for both projects in the **Solution Explorer** pane.

> Make sure you have done the steps under the "Correcting Paths To Necessary Files" heading for both projects in the Solution Explorer pane.

Fixing Some Core Files

If you try to debug your sketch now, it may warn of an "undefined referenced to `vtable for HardwareSerial'"

To fix this, open the **includes/core/HardwareSerial.h** file under the **ArduinoCore** project.

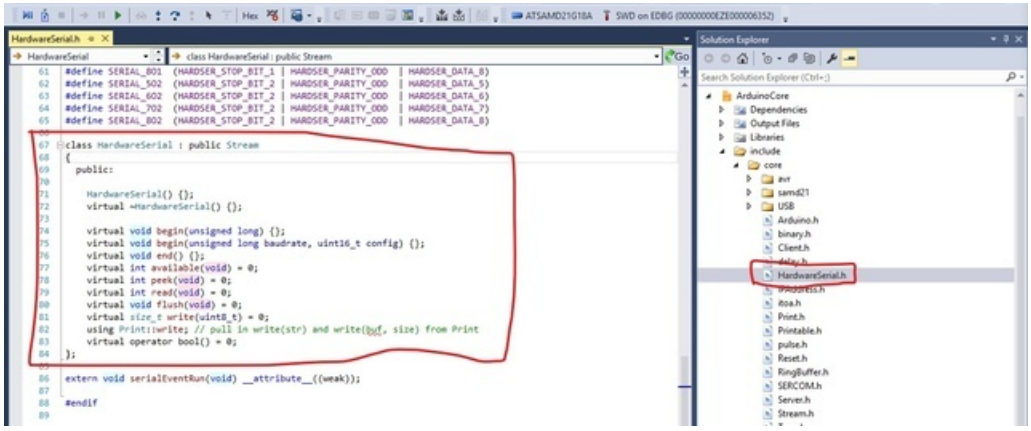
Scroll down to the class definition around line 67 and replace the class declaration with the following code:

```
class HardwareSerial : public Stream
{
  public:

 HardwareSerial() {};
 virtual ~HardwareSerial() {};

    virtual void begin(unsigned long) {};
    virtual void begin(unsigned long baudrate, uint16_t config) {};
    virtual void end() {};
    virtual int available(void) = 0;
    virtual int peek(void) = 0;
    virtual int read(void) = 0;
    virtual void flush(void) = 0;
    virtual size_t write(uint8_t) = 0;
    using Print::write; // pull in write(str) and write(buf, size) from Print
    virtual operator bool() = 0;
};
```

Your file should look like this:



Once this is done, you should be able to compile and debug your sketch!

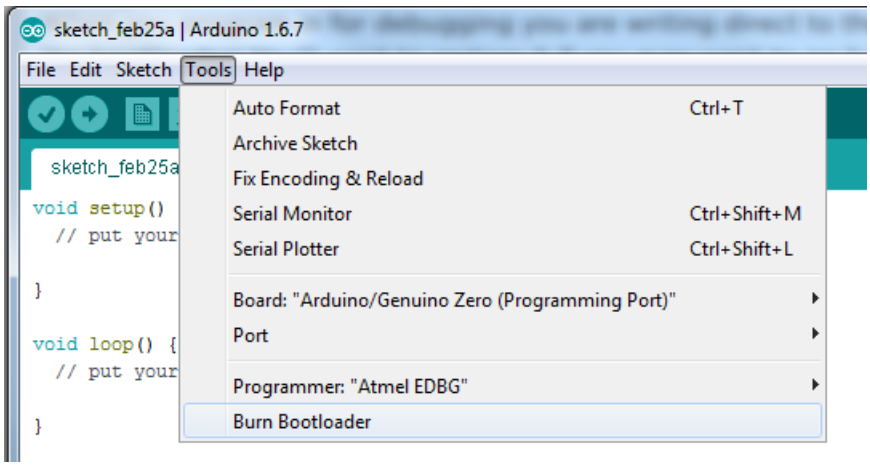
Restoring Bootloader

When you program in for debugging you are writing direct to the chip, this deletes the bootloader! You'll want to restore it if you ever want to go back to using the Arduino IDE.

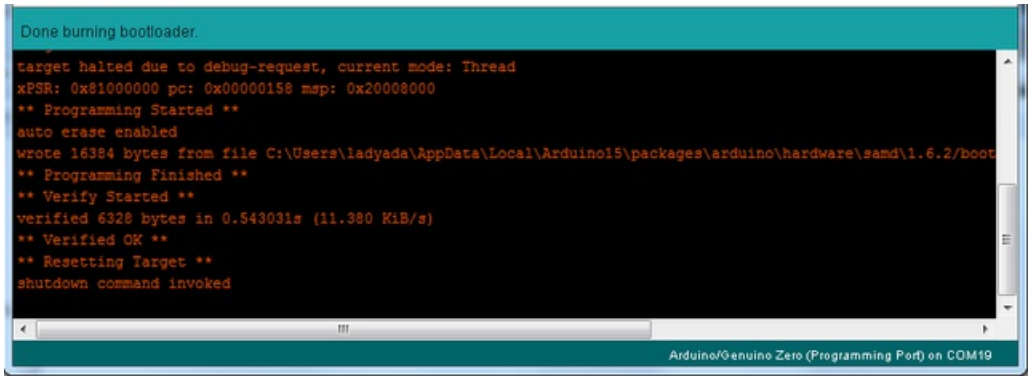
Arduino Zero

This is pretty easy. Launch the IDE, select **Arduino Zero (programming port)** from the **Tools->Board** menu, and **Atmel EDBG** as the **Tools->Programmer**

Then select **Burn Bootloader**



It only takes a few seconds to burn in the bootloader:



Feather M0 or Others

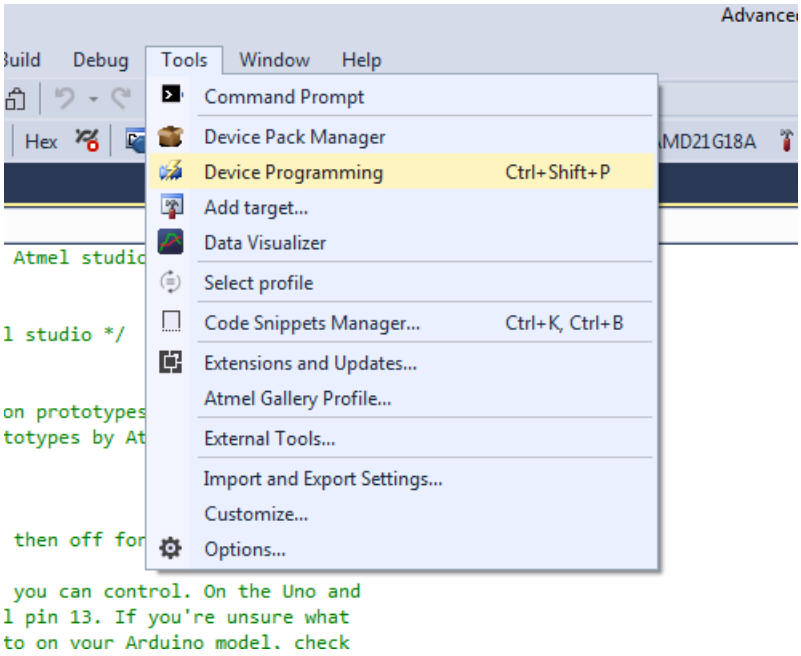
For this, you'll need to use the Atmel Studio setup, since you're using a J-Link.

Download the bootloader hex file

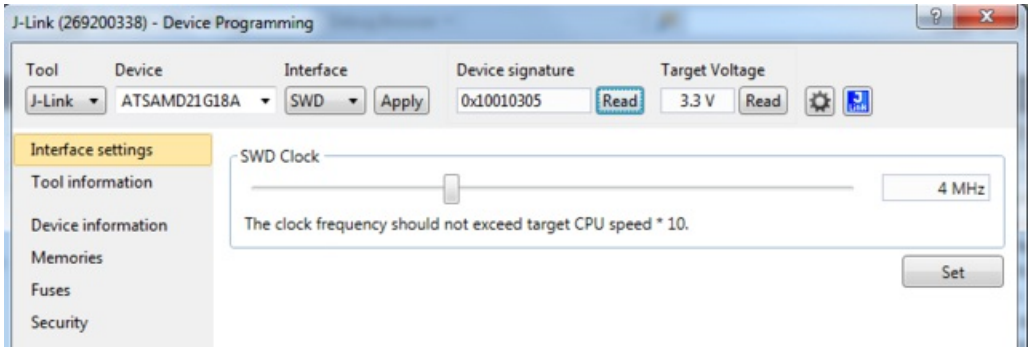
featherm0bootloader_160305.zip

https://adafru.it/mbG

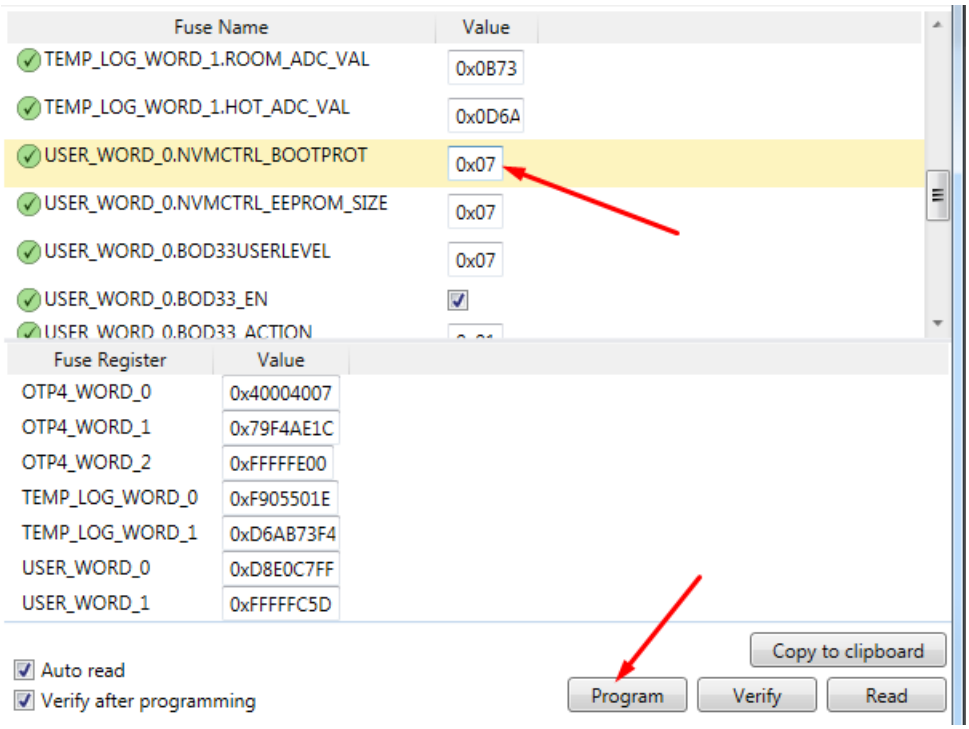
Wire it up correctly and select **Device Programming**



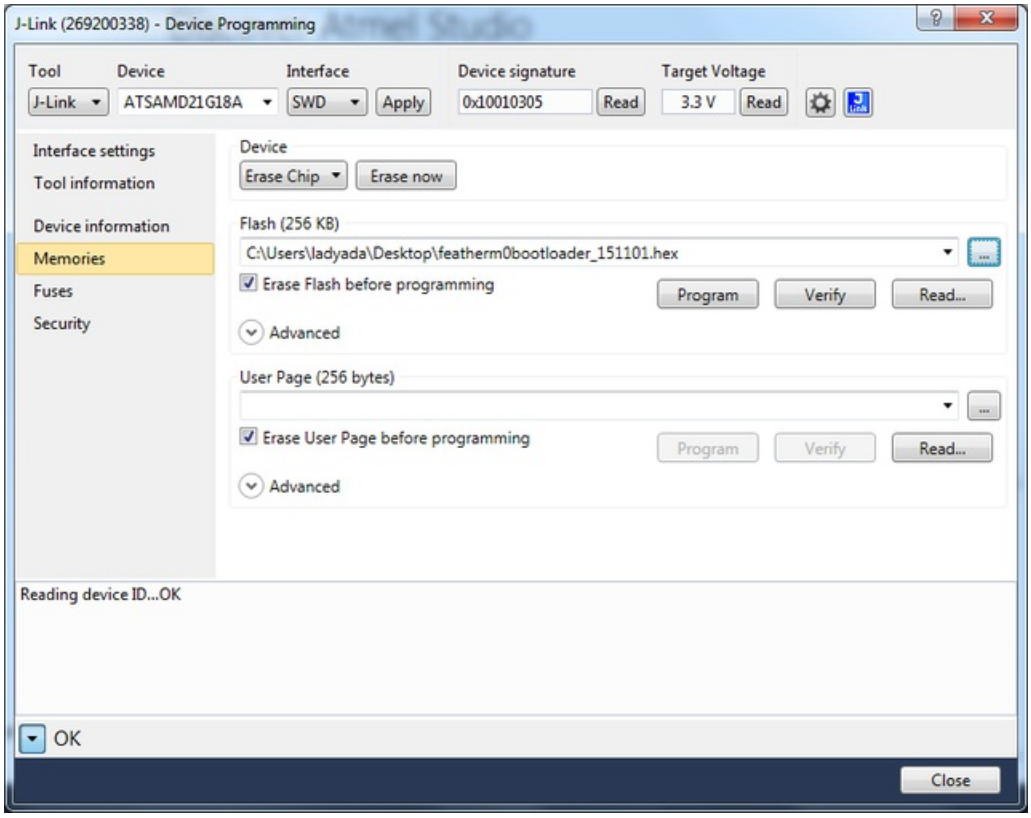
Select **J-Link** and the **ATSMD21G18A** with **SWD**. Verify you can read the Device Signature



Unlock the Bootloader protection by going to **Fuses** and changing **BOOTPROT** to `0x07` then programming

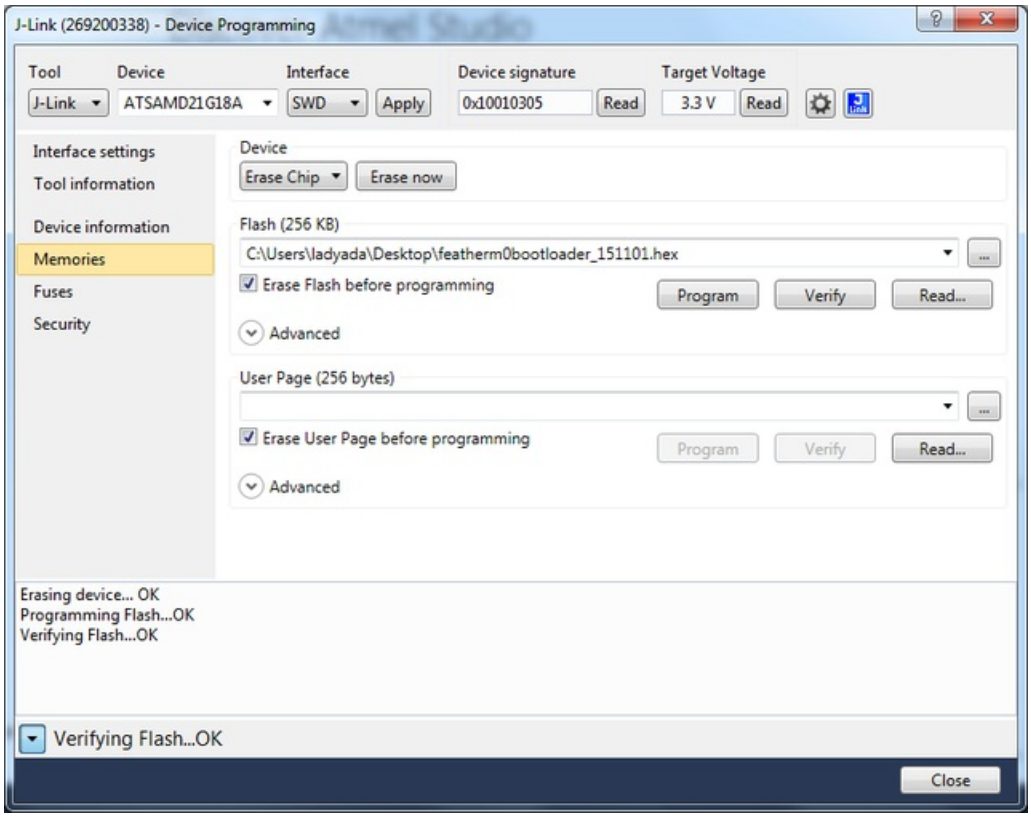


Next click on **Memories** in the left hand side



Next to the **Flash (256 KB)** section, click the triple-dots and select the bootloader file.

Then click **Program** to program it in


J-Link (269200338) - Device Programming
Tool
Device
Interface
Device signature
Target Voltage
J-Link
ATSAMD21G18A
SWD
Apply
0x10010305
Read
3.3 V
Read
Interface settings
Tool information
Device information
Memories
Fuses
Security
Device
Erase Chip
Erase now
Flash (256 KB)
C:\Users\ladyada\Desktop\featherm0bootloader_151101.hex
Erase Flash before programming
Program
Verify
Read...
Advanced
User Page (256 bytes)
Erase User Page before programming
Program
Verify
Read...
Advanced
Erasing device... OK
Programming Flash...OK
Verifying Flash...OK
Verifying Flash...OK
Close