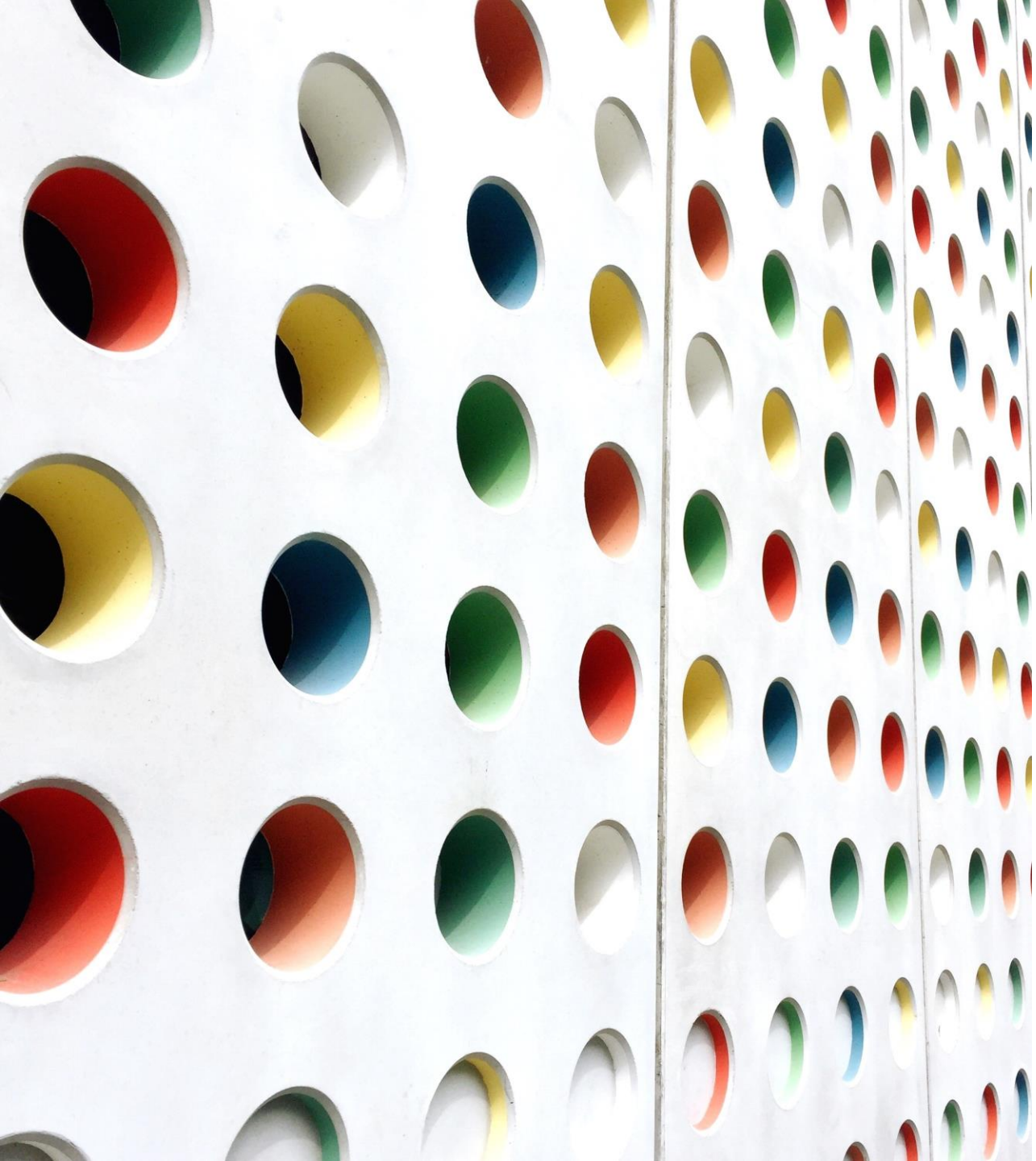


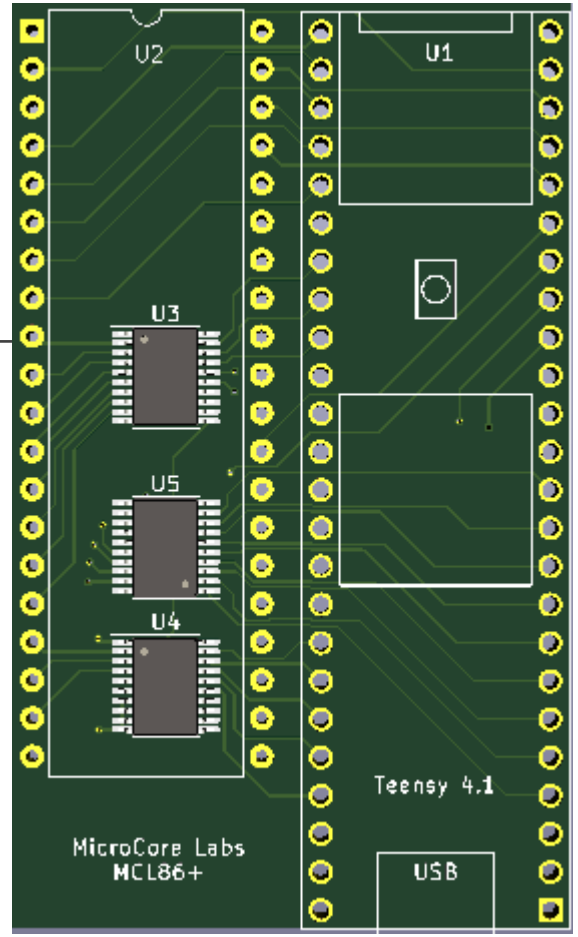
MicroCore Labs Emulators

HOW TO BUILD ONE

- CRAWFORD GRIFFITH
- VCF FORUM ID (CRAWFORD)

Contents

Overview of PCB



Hardware – MCLxx[+] Boards

One Job – safely connect the Teensy 4.1 pins to the CPU Socket

Actual Board at right

Fairly simple, 3-5 IC's, headers

buffers, latches mainly for 3.3V transition in and out of Teensy 4.1

Teensy on-board regulator takes in 5V and outputs 3.3V

Surface Mount Technology (scary!) - not really (discussed in the build section)

Overview of Software setup

Software Realities

- Have to install the Arduino IDE on a PC or Mac
- Have to install Teensyduino utility, from PJRC
- Have to set the Processor Speed in Arduino IDE menus*
- Have to set the Code Optimization level (hint – use Fastest)*

* Or use my forked code in github

Build information – Obtain PCB's

MCLxx[+] Boards - Got to make some boards! (or more accurately, get them made - best to farm these out)

- Overseas manufacturing (pluses and minuses)
  - JLCPCB and PCBWay are two companies that do this
  - Price-per-board is low ($25 or less for 5 boards)
  - Made very quickly (usually 48 hours or less)
  - Shipping is high (like $25) (or wait a few weeks)
  - You can get a solder paste stencil (if you're fancy)
  - Both JLCPCB and PCBWay can also assemble the SMT for you,
    - JLCPCB with their parts, and PCBWay with parts from Digikey, Mouser, etc.
  - Best to do a group buy, spread the cost

Build information – obtain components

Build Section – Board Components

Bare Boards:

Get the IC's from anywhere (Mouser, Digikey, eBay)

They are TSSOP-20 (0.65mm pin spacing) exception: DIP packages for MCL65+

Remember to get 3.3V chips (5V tolerant), generally 74HC or 74LVC or 74AHC

All Boards:

Headers - get 40 pin Male-male machine pin for the plug into the CPU socket (PCB bottom)

- get 40 pin male and female "Arduino-like but longer" (PCB top)

- Teensy 4.1 is 48 pins (24 to the side)

Build information – Soldering IC's (PCB vendor option)

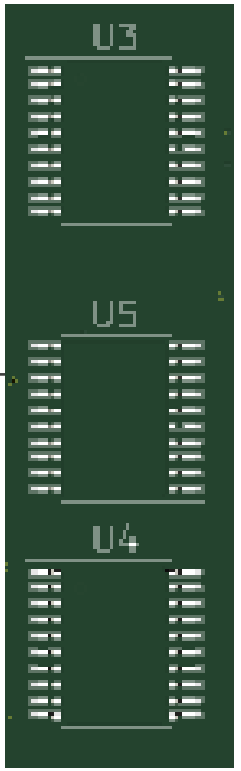
Build Section – As Easy as 1-2-3! - Soldering 1a

---------- OPTION A ----------

Have the PCB shop assemble the SMT

Most have this service

Build information – Soldering IC's (hand solder option)



Build Section – Soldering 1b – it's not terribly hard

---------- OPTION B ----------

Good soldering station, fine soldering tip, thin solder, solder wick and a MAGNIFYING GLASS

Surface Mount Technology (SMT) chips - YOICKS!

LOOK AT THE LAYOUT-HARD TO SEE THE PIN 1 INDICATION, THE CHIPS DO NOT ALL HAVE THE SAME ORIENTATION

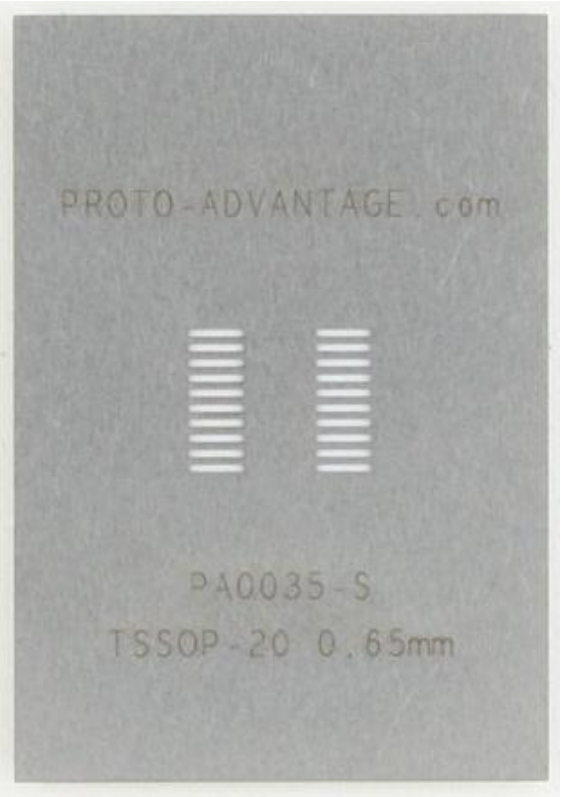
Steady hands - these are TSSOP-20 0.65mm chips

Center the chips, solder pin 1, recenter and solder pin 11 (opposite corner)

LOOK AT THE PIN ONE INDICATORS, IT IS BETTER TO DESOLDER 2 PINS THAN 20! DO NOT ASK ME HOW I KNOW THIS!

Solder the rest of the pins

Build information – Soldering IC's (solder paste stencil/hot air option)



Build Section – Soldering 1c

---------- OPTION C ----------

Use the solder stencil

Apply solder paste with a credit card

Peel off the solder stencil carefully

Center the chips carefully on the solder

Pre-heat board on a hot plate

Hit it with the hot air station (heat high, air low so you don't send chips airborne)

Watch with wonder as the chips magically move to the exact right place

Build information – Teensy Headers

Build Section – Soldering 2 – Teensy Headers

- Inspect the SMT chip pins for bridges, use solder wick dipped in flux to fix
- Install Teensy headers
  - Solder male "Arduino-like" headers to the underside of the Teensy 4.1 board (if not supplied)
  - Long "Arduino-like" female headers on top of the PCB, use the Teensy w/headers to hold them parallel
  - Push the header up from the underside, tack down the end pins
  - Check that the headers are tight to the board
  - Solder the other pins down

Build information – CPU headers

Build Section – Soldering 3 – CPU Headers

Install CPU headers

put the side of the header with thinner pins into a 40 pin socket

put the headers through the underside of the PCB

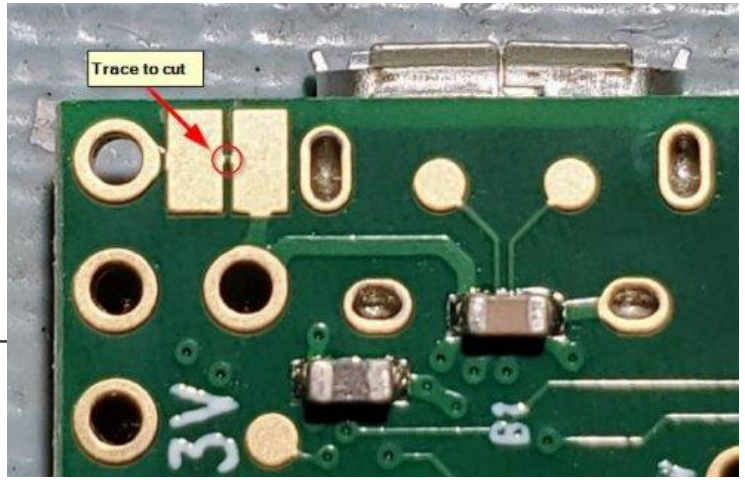
turn the board over holding the socket+headers tight to the underside of the board

solder the end pins (1, 20, 21, 40)

check the headers are tight to the board

solder the other pins down

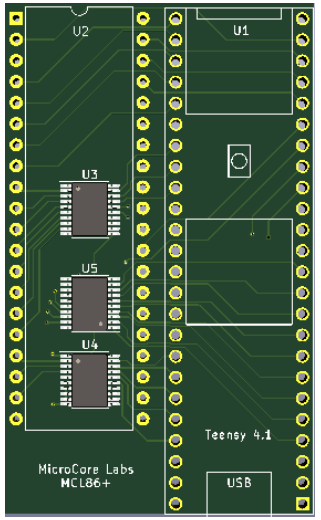
Build information - Final assembly



Build Section - final assembly

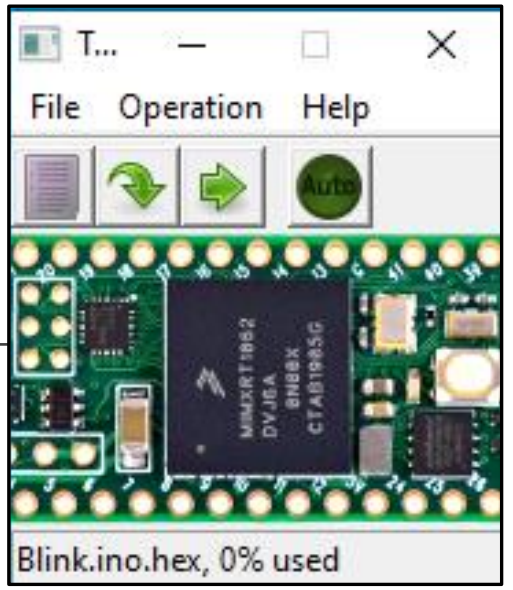
- Give the Teensy 4.1 some minor surgery (or delay this until you program the Teensy)
- Cut the pad near Vcc, so that the USB cable does not try to power the target system!
- Plug the Teensy 4.1 board into the header

  (look at the outline and make sure the sd card holder and usb are lined up)



Build information – Compile and Flash software

Build section - Software



- Download the software for the board from Github (RAW Download)
- Install the Arduino IDE or update yours to the latest, install Teensyduino from PJRC.com
- Launch the Arduino IDE
- Go to board manager and search for Teensy, load the library
- Start a new project and navigate to the MCLxx.INO file and open it
- Immediately set the board to Teensy 4.1
- Set the Speed to 816Mhz
- Set the Optimization to Fastest
- Cross fingers
- Plug in MCLxx[+] board into a power source if the Vcc pad was cut
- Plug a USB micro cable into the Teensy (make sure it is not a charge-only cable)
- Cross fingers and hit the compile/Verify button on the IDE
- When the Teensy programmer pop-up shows, press the white button on the Teensy
- Smile when the programmer reports the teensy is programmed and reset okay

Ideas for what you can do with these things

Accelerate your machine – Ted has already added this in most of the existing code

Write code [or port] a system test process in C and run it on the Teensy
-> there is already one done for the Commodore 64 !

Get a machine to boot that does not have some vital hardware, like tape (paper or plastic),
serial port, video out, keyboard, diskette or Hard disk

Easily mirror, or even increase system RAM size or try different ROM versions using emulated memory inside the Teensy

Expand a machine using the SD card or fast serial over USB - teensy as a USB host

Add networking with Ethernet (yeah, Teensy 4.1 has that too)

Emulate an extremely rare piece of hardware (like the OSI Hard disk)

Put a new (or expanded) instruction set into your computer (see the MicroCore Labs 68000 in an IBM PC)

Emulate another CPU : 65816, 6800, 6809, PDP-11, Harris 6120 ...

More info – Links, contact info, stuff

Crawford's fork of MCL projects - Github.com/CrawfordGriffith

Amazon Link for Male-male machine pin headers (for CPU socket)

Amazon Link for 40-pin "Arduino-like" heaters (male and female)

PJRC Downloads