

AccessionIndex: TCD-SCSS-T.20250918.002

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Accession By: Dr.Brian Coghlan and Erturk Kocalar

Object name: Arduino shield for Intel 8008

Vintage: 2025

Synopsis: A board that enables execution of software by the 8008, Intel's very early 8-bit microprocessor.

Description:

This Retrosshield 8008 is one a series of Arduino shields (*retrosields*) designed by Erturk Kocalar [1] to not only host early microprocessors but also to execute their original native software, an approach he has termed "Breadboarding in Software".

The RetroShield 8008 [2] is a daughter card that plugs into an Arduino Mega [3] or Teensy [4], see Fig.1. The Intel 8008 microprocessor [5] executes native 8008 code while the Arduino emulates 8008 system hardware. The choice of emulated 8008 system hardware is done by uploading relevant Arduino code. This enables the experience of old computer systems, the learning of low-level aspects of the early microprocessors, the keeping of valuable historical software alive, and even changing original native software simply by changing C code in the Arduino IDE, and use with other Arduino shields and libraries.

The Arduino Mega is an inexpensive platform with a 16MHz CPU that allows the retrosshield's early microprocessor to run at about up to 400kHz, with over 200kB of emulated ROM and about 6kB of emulated RAM (reserving 2kB for the Arduino stack/heap). Peripherals like a UART, PIA, Timer, etc. can be emulated by the Arduino, and other Arduino *shields* can be used to add new features. The Arduino Mega operates at 5V TTL levels. The retrosshield plugs into the Arduino Mega digital input/output connector.

The Teensy is a more expensive but faster platform with a 600MHz CPU that allows the retrosshield's early microprocessor to run at full speed (e.g. 1MHz), with over 512kB of emulated ROM. Emulated RAM capacity depends on the Teensy version, 256kB for Teensy 3.5 or 3.6, 1MB for Teensy 4.1. It includes a microSD slot that can be used to emulate disk drives. Other peripherals like a UART, PIA, Timer, etc. can be emulated by the Arduino, and other Arduino *shields* can be used to add new features. The Teensy operates at 3.3V, but plugs into a Teensy daughter card designed by Erturk Kocalar that provides onboard 3.3V-to-5V TTL level shifting & vice-versa. The retrosshield then plugs into that daughter card in the same way that it would into an Arduino Mega digital input/output connector.

The Intel 8008 was the world's first commercially available 8-bit microprocessor, designed by Hal Feeney under the supervision of Federico Faggin, who designed Intel's 4004 chips. Unlike the 4004, the design history of the 8008 is well known and undisputed, see [5]. It did have its curiosities. It had two power supply pins: +5V and -9V, but no GND=0V pin. The 8008 inputs and outputs were TTL-compatible. Much more curiously, due to Intel's policy of resistance to more than 16-pin packaging and despite Faggin's protests, it had just 18 pins, see Fig.2, with an *Interrupt* pin that required external injection of an interrupt handler instruction, but no *Reset* pin. On power-up, the 8008 reset its PC to 0x0000, then executed a HALT instruction, so then

the interrupt pin had to be activated to start the boot process, hence the Reset button of the Teensy daughter card feeds to the Teensy to trigger Interrupt/Reset. The Retroschild 8008 design files are at [6].

Like Intel's 4004, the 8008 required multiple clock cycles to execute instructions, typically with states T1/T2 for address, T3 for instruction fetch, then T4/T5 for execution, see Fig.3. SYNC indicated the beginning of each processor cycle. Unlike the 4004, the 8008 had a reasonably sensible register set, see Fig.4.

The Retroschild 8008 can execute the native Intellec 8/Mod 8 ROM-resident monitor [7][8] that supports memory, a PROM programmer, a tape/punch, and a Teletype. An Editor/Assembler for this appears to have been lost. It can also execute native SCELBAL (SCientific ELementary BAsic Language) [9], which is documented in book form [10] and has floating point mathematical functions (sin, cos, exp, log, atn, and strings and arrays). The Retroschild 8008 software is at [11].

Many thanks to Erturk Kocalar and Brian Coghlan for donating this item.

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TCD-SCSS-T.20250918.001	Intel 8008 microprocessor. Intel's first and very early 8-bit microprocessor. 1972.
TCD-SCSS-X.20250916.001	Dr.Brian Coghlan's Collection of Early Microprocessors. An extensive and nearly complete set of unused 1970s microprocessor chips, most accompanied with documentation, some with demonstration boards. 1971.

References:

1. Erturk Kocalar, *8bitforce*, erturkk@8bitforce.com, see:
<https://8bitforce.com/>
Also: <https://gitlab.com/8bitforce>
Last browsed to on 18-Sep-2025.
2. Erturk Kocalar, *Retrosshield 8008*, see:
<https://www.tindie.com/products/8bitforce/retrosshield-8008-for-arduino-mega/>
Last browsed to on 18-Sep-2025.
3. Arduino, *Arduino MEGA*, see:
<https://store-usa.arduino.cc/products/arduino-mega-2560-rev3>
Last browsed to on 18-Sep-2025.
4. PJRC, *Arduino Teensy*, see:
<https://www.pjrc.com/teensy/>
Last browsed to on 18-Sep-2025.
5. Wikipedia, *Intel 8008*, see:
https://en.wikipedia.org/wiki/Intel_8008
Last browsed to on 18-Sep-2025.
6. Erturk Kocalar, *Retrosshield-HW Design Files*, see:
<https://gitlab.com/8bitforce/retrosshield-hw>
Last browsed to on 18-Sep-2025.
7. Wikipedia, *Intellec*, see:
<https://en.wikipedia.org/wiki/Intellec>
Last browsed to on 18-Sep-2025.
8. Herb Johnson, *Intel MON-80 PROMs and systems*, 2024, see:
https://www.retrotechnology.com/restore/mon80_proms.html
Last browsed to on 18-Sep-2025.
9. SCELBI Computer Museum, *SCELBI*, see:
<https://www.scelbi.com/>
Last browsed to on 18-Sep-2025.
10. Mark Arnold and Nat Wadsworth, *SCELBAL: A Higher Level Language for 8008/8080 Systems*, pp.372, Scelbi Computer Consulting, 1976, see:
<https://www.scelbi.com/>
Last browsed to on 18-Sep-2025.
11. Erturk Kocalar, *Retrosshield 8008 Source Code*, see:
<https://gitlab.com/8bitforce/retrosshield-teensy/-/tree/master/t8008>
Last browsed to on 18-Sep-2025.

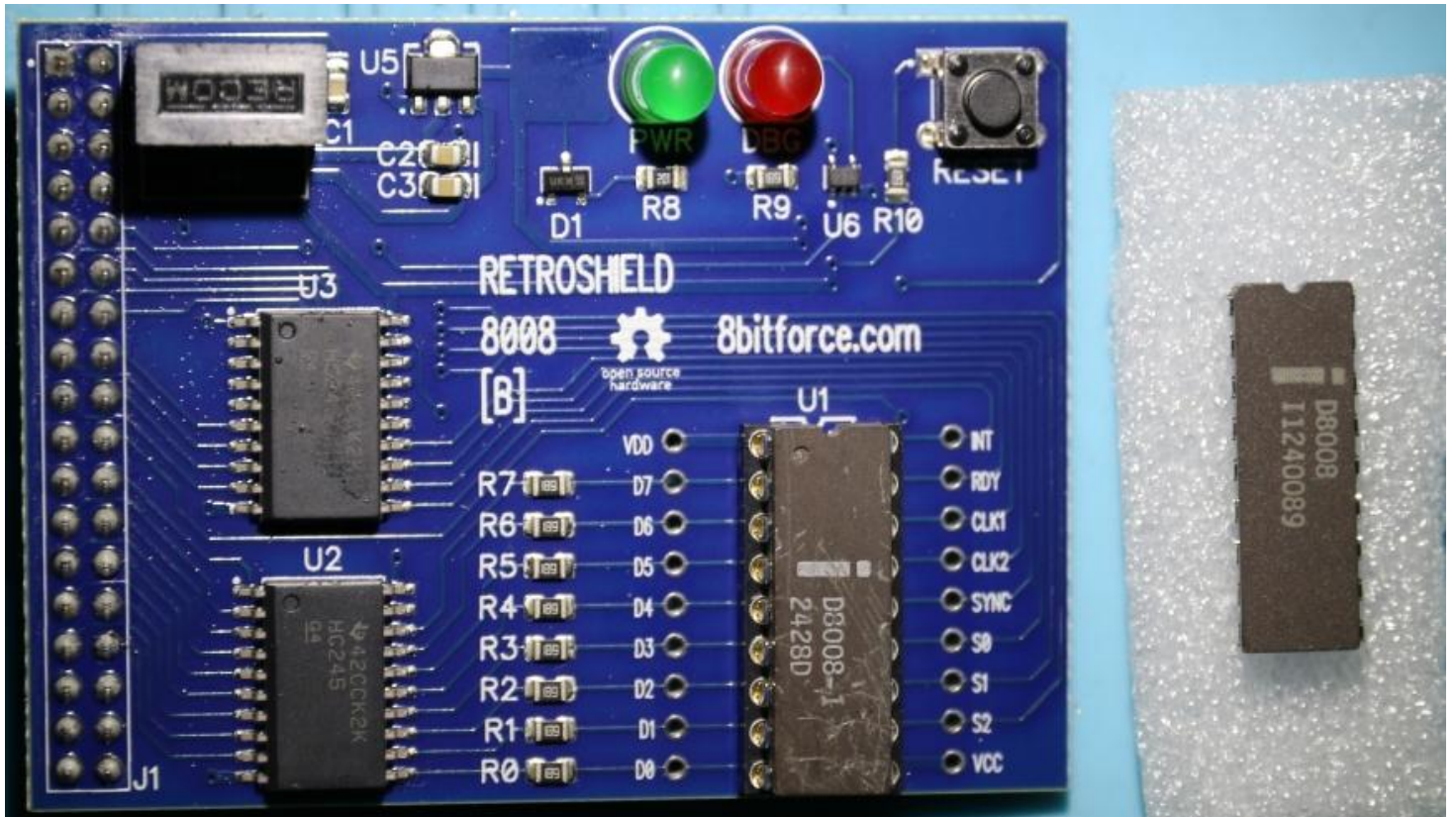


Figure 1: Left: 8bitforce Retroschild 8008, Right: Intel 8008 8-bit microprocessor.

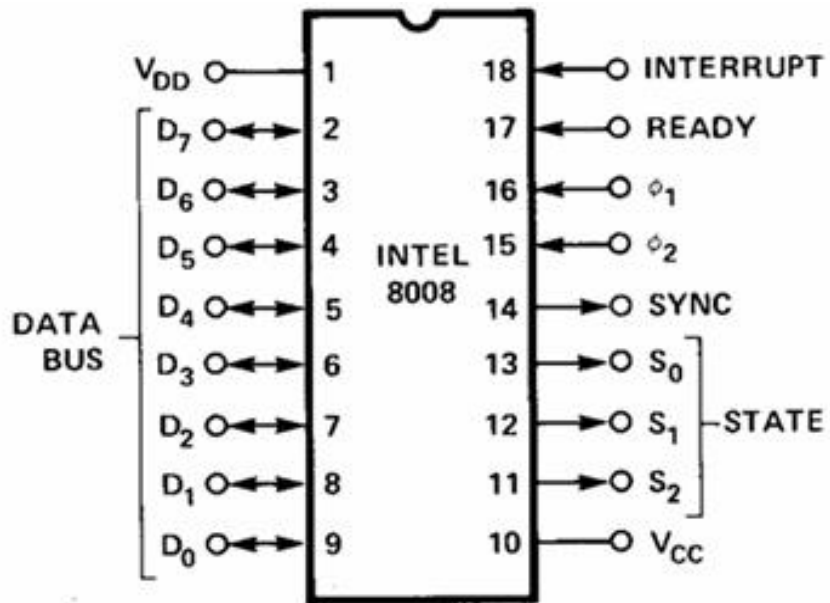


Figure 2: Intel 8008 pinout (from Wikipedia).

Intel 8008 Microarchitecture

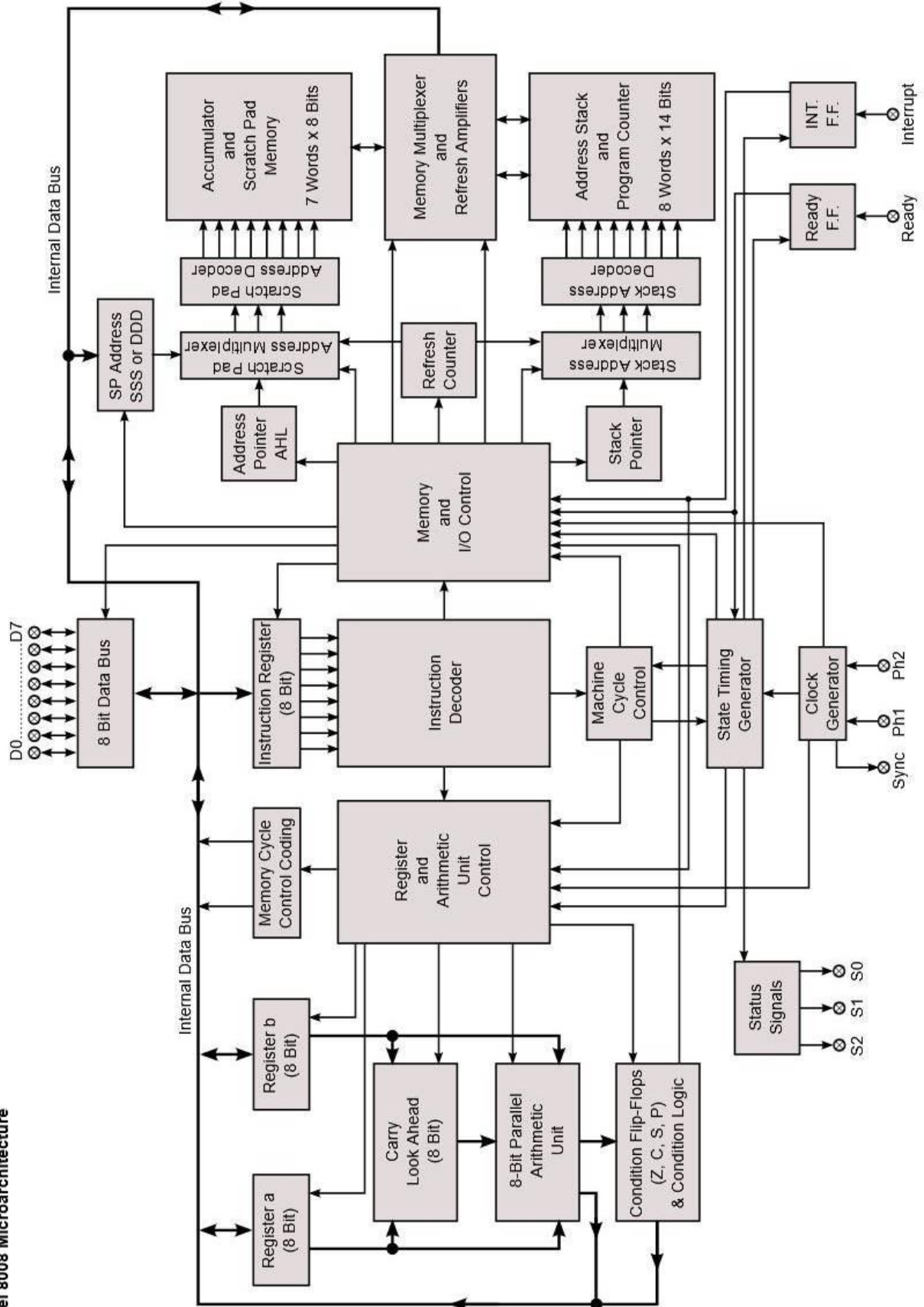


Figure 3: Intel 8008 architecture (from Wikipedia).

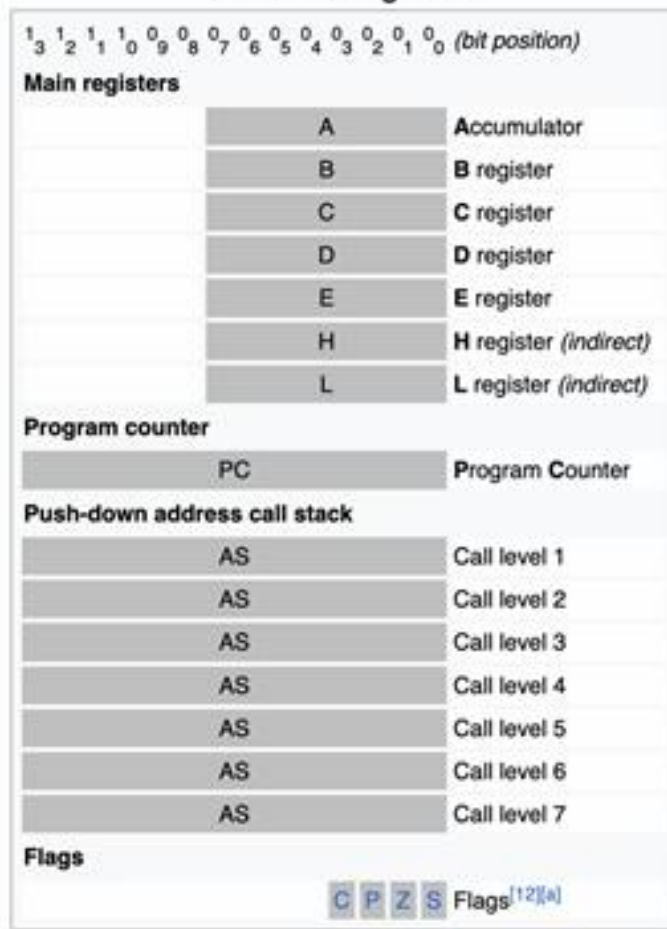


Figure 4: Intel 8008 registers (from 8bitforce).

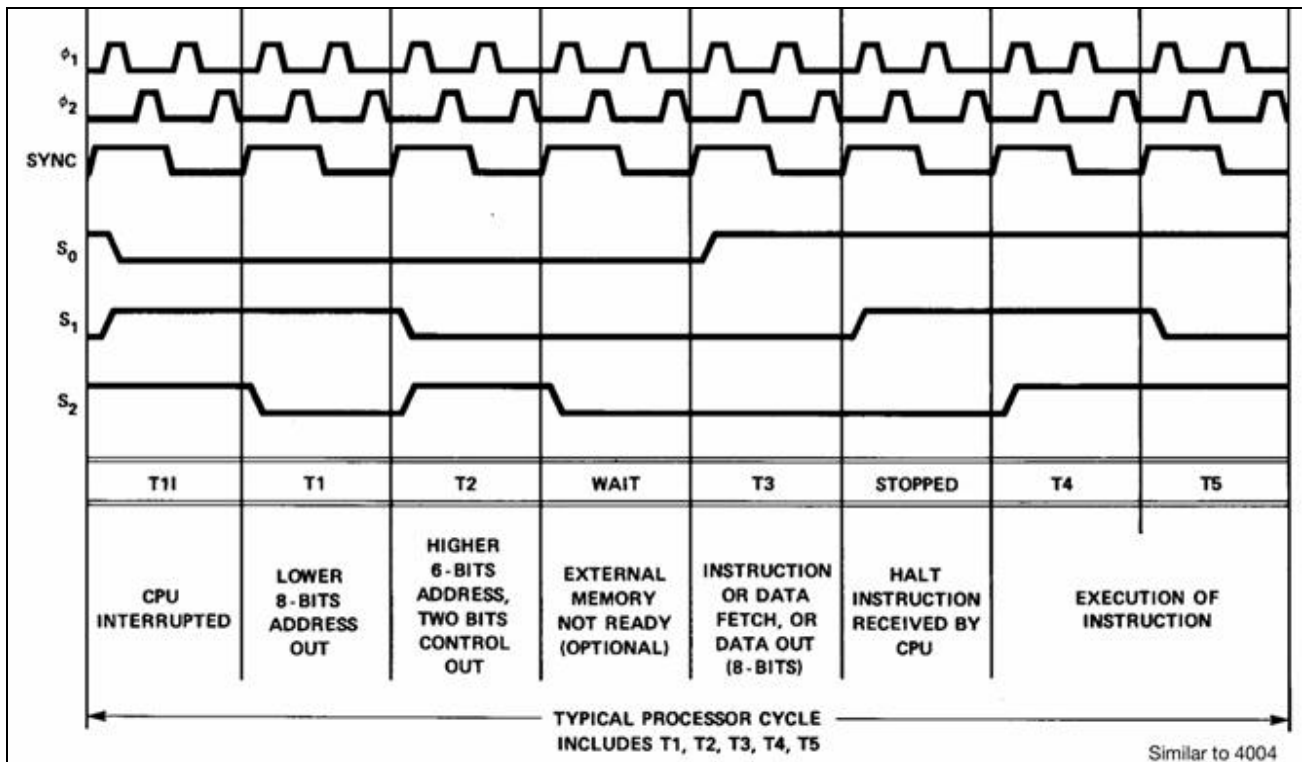


Figure 5: Intel 8008 instruction cycle (from 8bitforce).

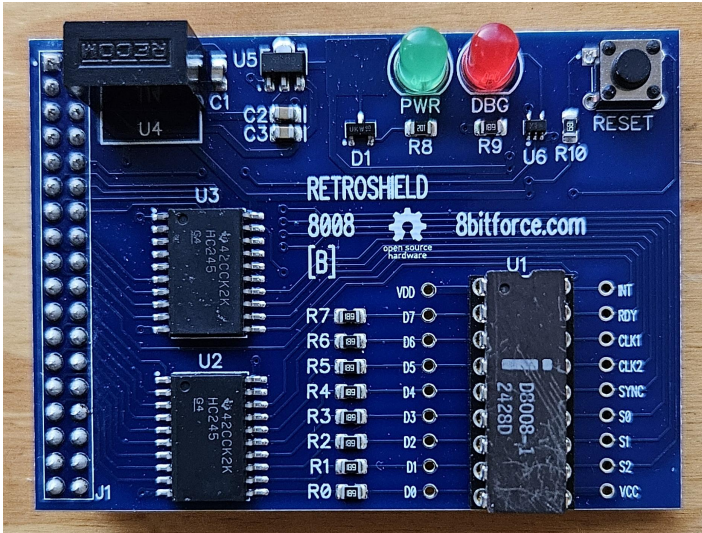


Figure 6: 8bitforce Retroschild 8008.

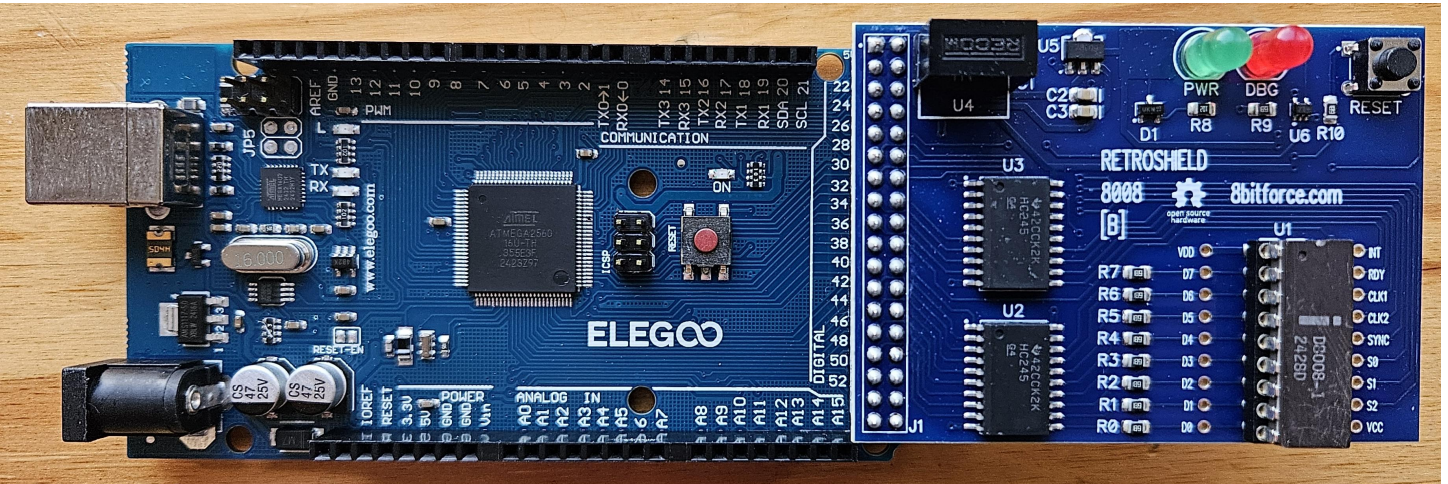


Figure 7: 8bitforce Retroschild 8008 coupled with Arduino Mega.

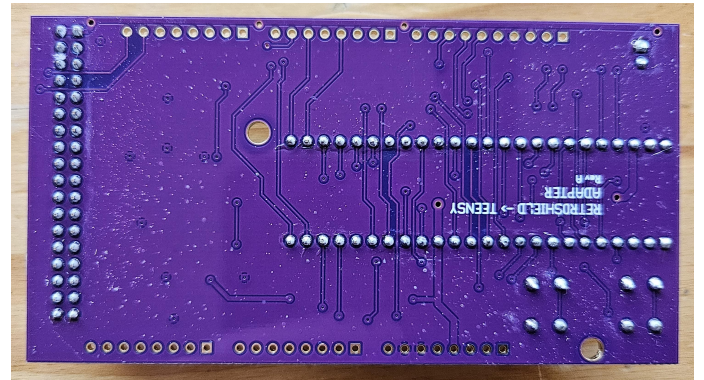
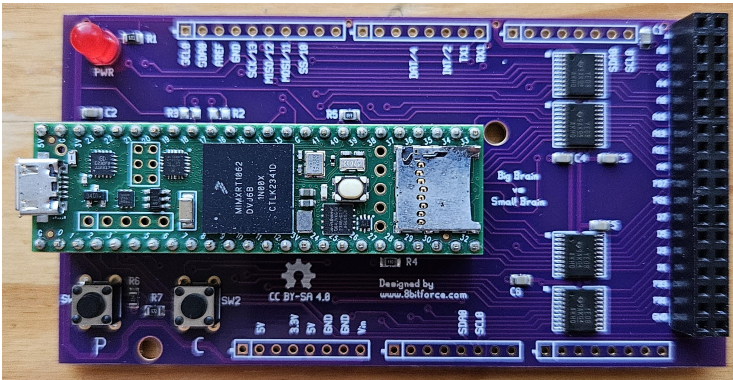


Figure 8: 8bitforce Retroschild Teensy.

RetroShield 8008 Assembly Instructions

Rev B, 2025/01/29

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Solder parts from shortest to tallest:

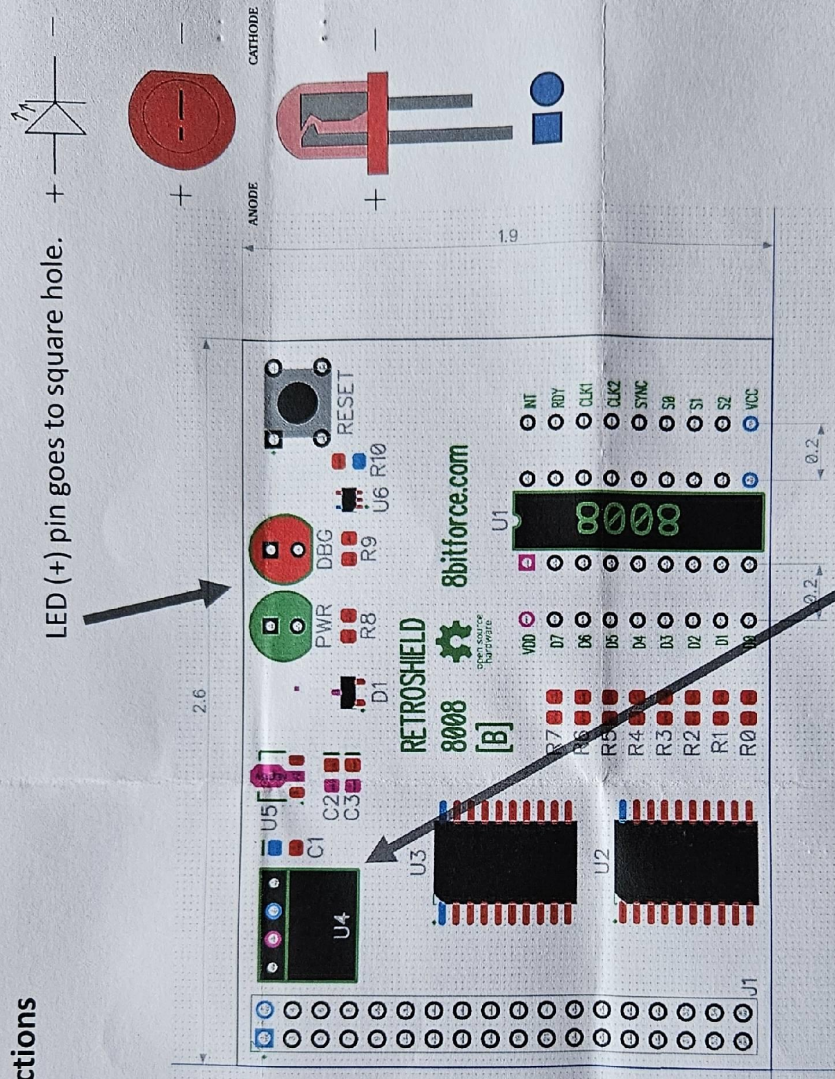
J1 header = on bottom side

Socket = U1 socket

SW = Switch

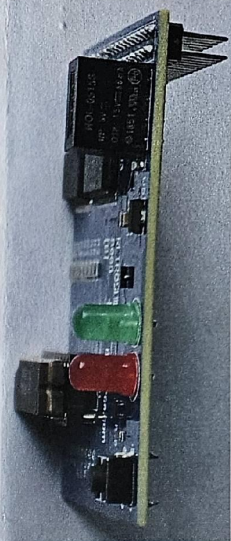
LED's = Match colors as shown

DC/DC module = text facing outside.



LED (+) pin goes to square hole.

DC/DC module text facing outside.



https://commons.wikimedia.org/wiki/File:%2B_of_LED_2.svg

Figure 9: 8bitforce Retroshield 8008 assembly instructions.

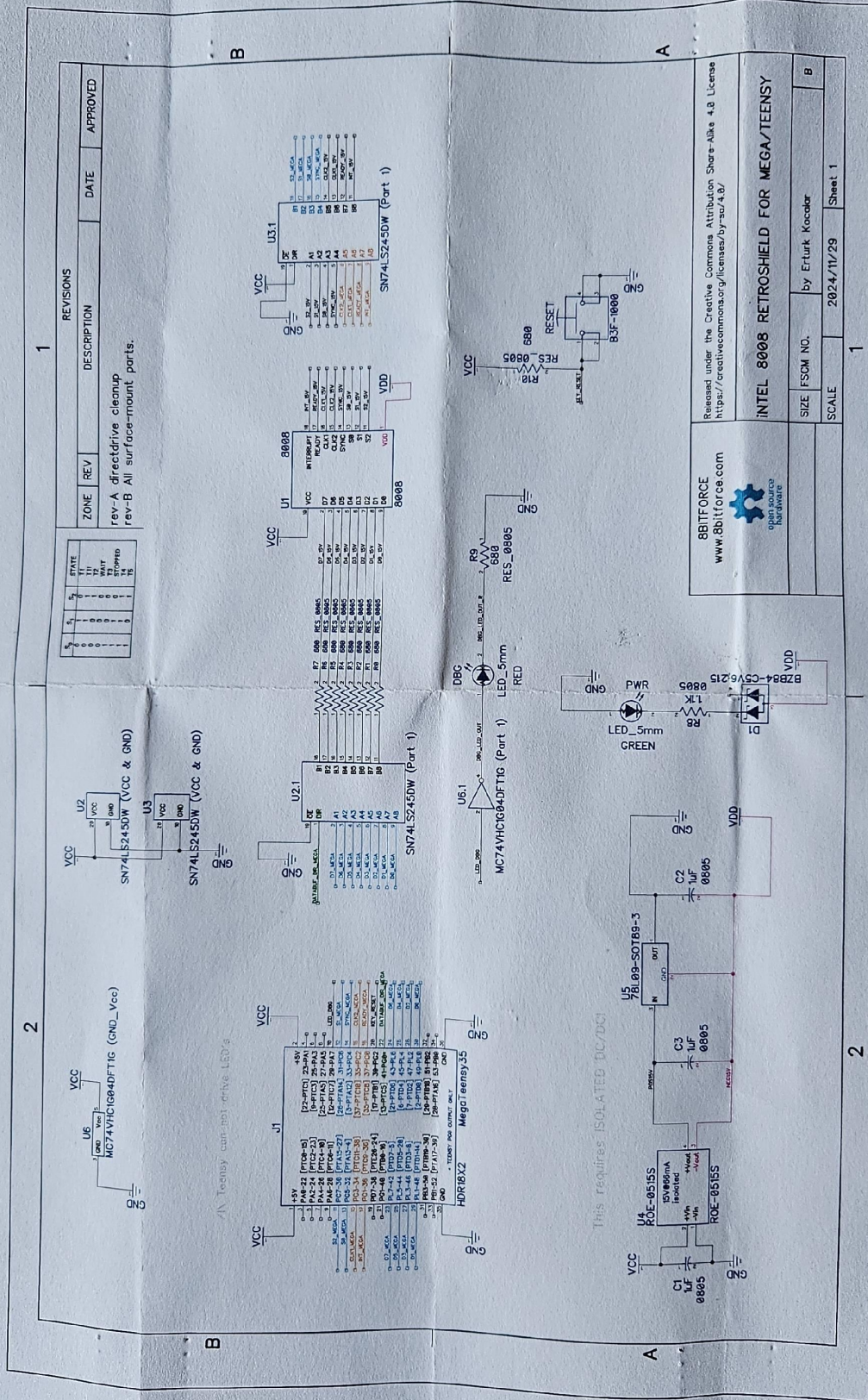


Figure 10: 8bitforce Retrosshield 8008 schematic.

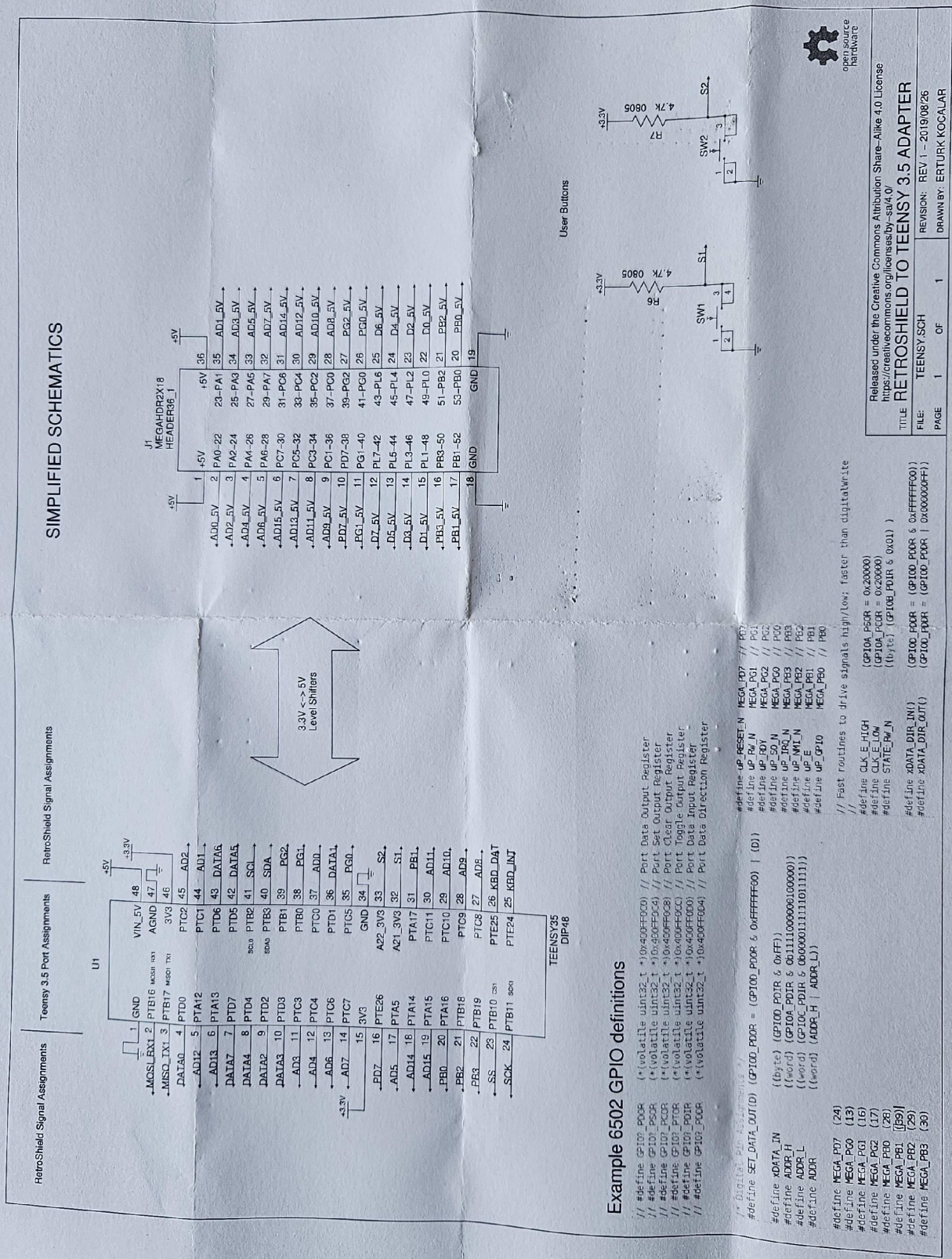


Figure 12: 8bitforce Retroshield Teensy simplified schematic.