AccessionIndex: TCD-SCSS-T.20250921.002
Accession Date: 21-Sep-2025
Accession By: Dr.Brian Coghlan and Erturk Kocalar
Object name: Arduino shield for Signetics 2650
Vintage: 2025
Synopsis: A board that enables execution of software by the 2650, an early 8-bit microprocessor designed by John Kessler modelled on the IBM 1130.

Description:
This Retroshield 2650 is one a series of Arduino shields (*retroshields*) 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 2650 [2] is a daughter card that plugs into an Arduino Mega [3] or Teensy [4], see Fig.1. The Signetics 2650 microprocessor [5] executes native 2650 code while the Arduino emulates 2650 system hardware. The choice of emulated 2650 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 retroshield’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 retroshield 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 retroshield’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 retroshield then plugs into that daughter card in the same way that it would into an Arduino Mega digital input/output connector.

The Signetics 2650 was an early microprocessor design designed by John Kessler and Kent Andreas in 1972, that was modelled on the IBM 1130 minicomputer, although the eventual resemblance was not obvious, and that unfortunately included memory segmentation into 8kB pages out of a limit of 32kB of memory [5][6][7][8]. However, it did have nice features such as an on-chip stack and vectored interrupts, and was a purely static design (hence the clock could be single-stepped for debugging software), manufactured using nMOS technology and only needing a single 5V supply. But because it wasn’t manufactured until 1975, when more developed architectures like the Intel 8080 and Motorola 6800 had emerged, it could not compete as successfully

as it may have in 1972. It is rumoured that Signetics chips were not renowned for their long lifetimes due to metalisation creep and other issues, but that has not been confirmed. RetroShield 2650 was the first of the retroshield series. This retroshield will work with an Arduino Mega 2560 or Teensy 3.5, but not other Teensy versions due to their weak processor output buffers and/or incompatible port assignments. The design files for the Retroshield 2650 are at [9].

The Retroshield 2650 can execute the Signetics Pipbug debugger, and also some programs (go_away, guessing_game, nim) from the 1977 publication, *Getting Into Microprocessors* [10][11]. The Retroshield 2650 software is at [12].

An alternative retro 2650 has been implemented using a Raspberry Pi RP2350B that can execute the Signetics Monitor ROM, Pipbug, and Othello (aka Reversi), hosted by an RP2350B application IcePi written in Oberon using the Astrobe IDE [13].

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

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Some of the items below may be more properly part of other categories of this catalog, but are listed here for convenience.

Accession Index	Object with Identification
TCD-SCSS-T.20250921.002	Arduino shield for Signetics 2650. A board that enables execution of software by the 2650, an early 8-bit microprocessor designed by John Kessler modelled on the IBM 1130, 2025.
TCD-SCSS-T.20250921.001	Signetics 2650 and associated chips. An early 8-bit microprocessor designed by John Kessler modelled on the IBM 1130, 2025.
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:

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   Also: https://gitlab.com/8bitforce
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2. Erturk Kocalar, *Retroshield 2650*, see:
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   Also: https://treasures.scss.tcd.ie/hardware/TCD-SCSS-T.20250921.002/Signetics-2650-and-2636-programming-Wikibooks.pdf
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9. Erturk Kocalar, *Retroshield-HW Design Files*, see:
   https://gitlab.com/8bitforce/retroshield-hw
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12. Erturk Kocalar, *Retroshield 2650 Source Code*, see:
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13. RaspberryPi Forums, *RP2350B / Signetics 2650 Retrocomputing Prototype*, see:
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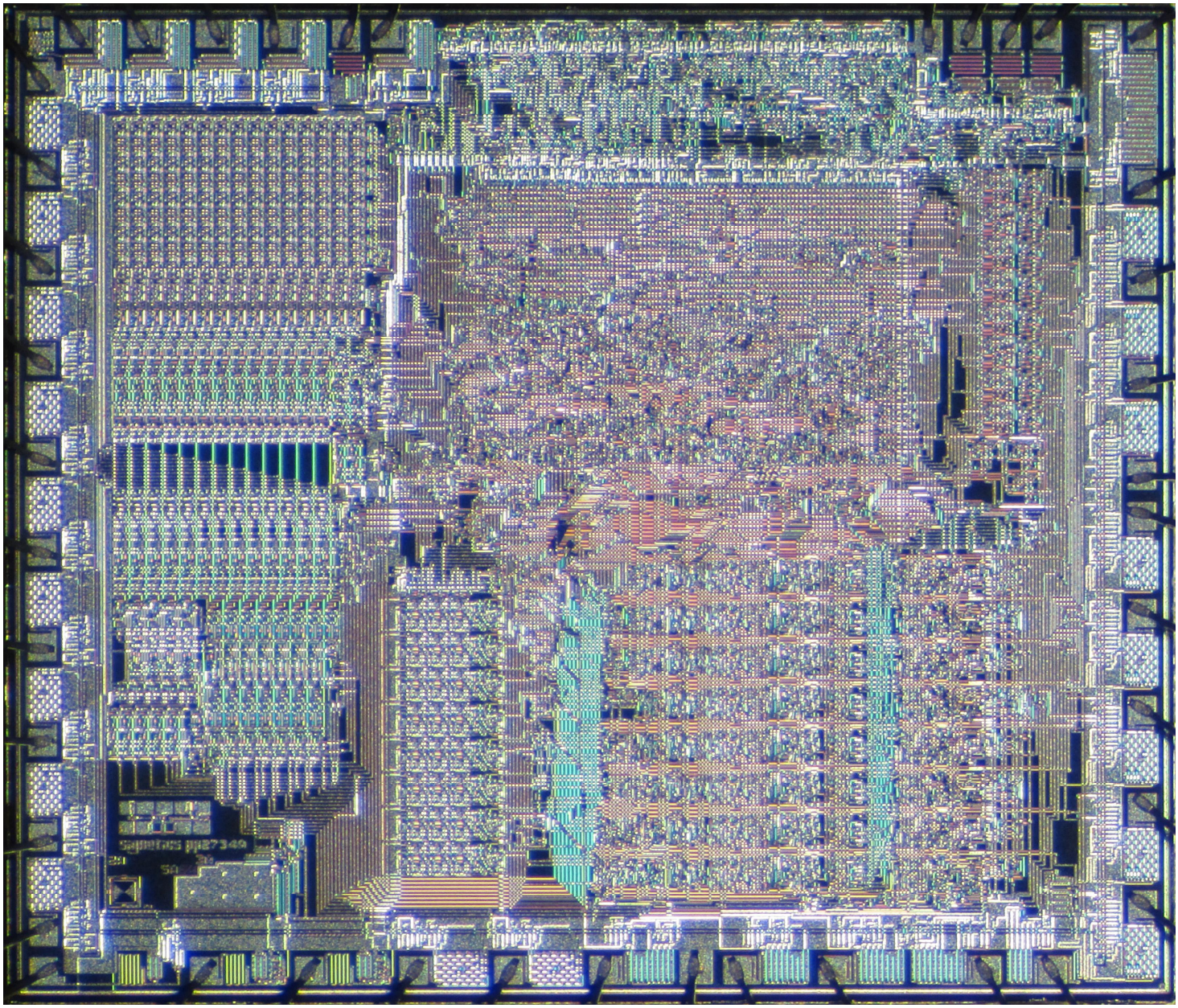


Figure 1: Signetics 2650 chip die micrograph (from Wikipedia).

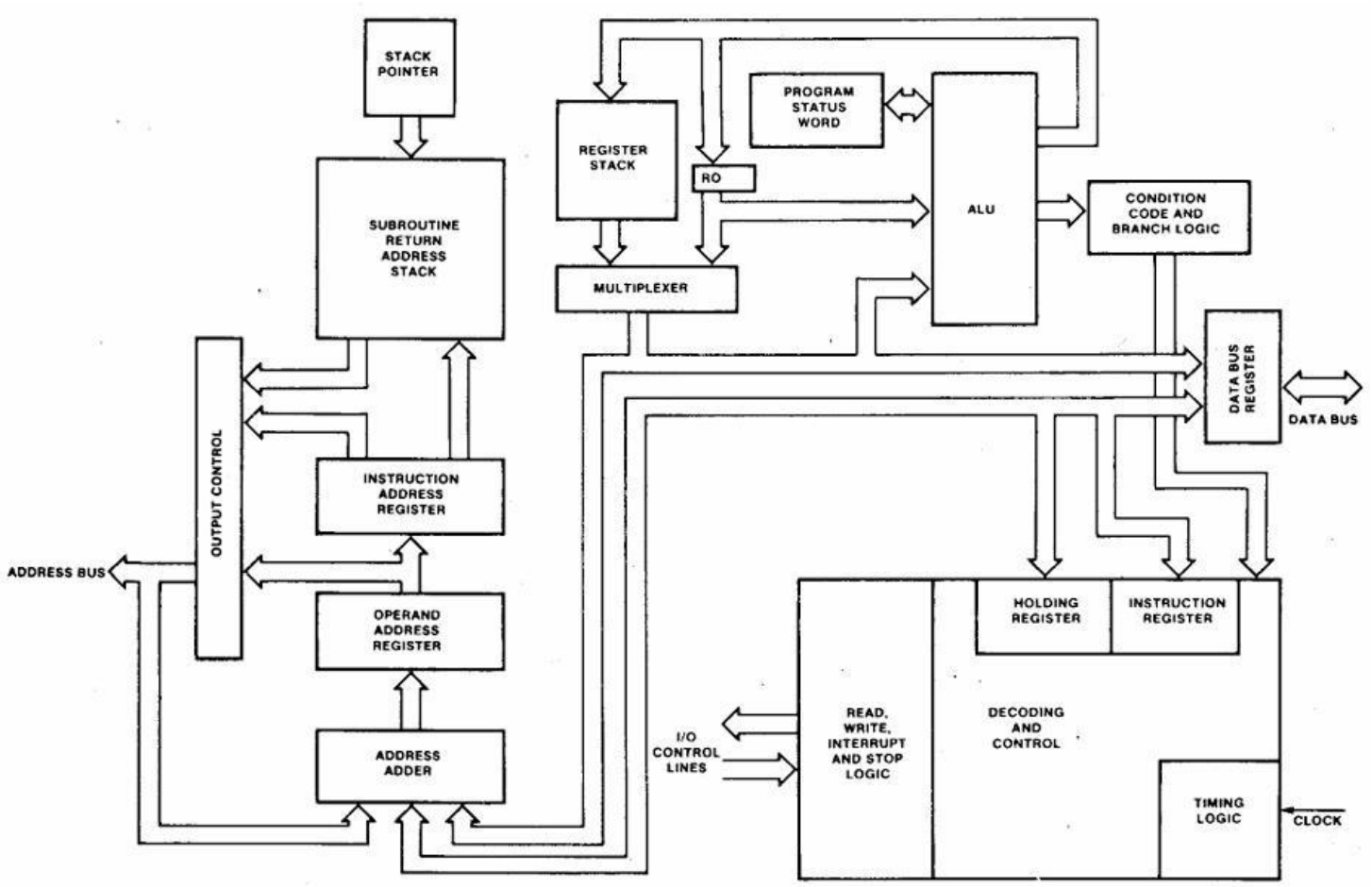


Figure 2: Signetics 2650 architecture (from Philips).

Signetics 2650 registers

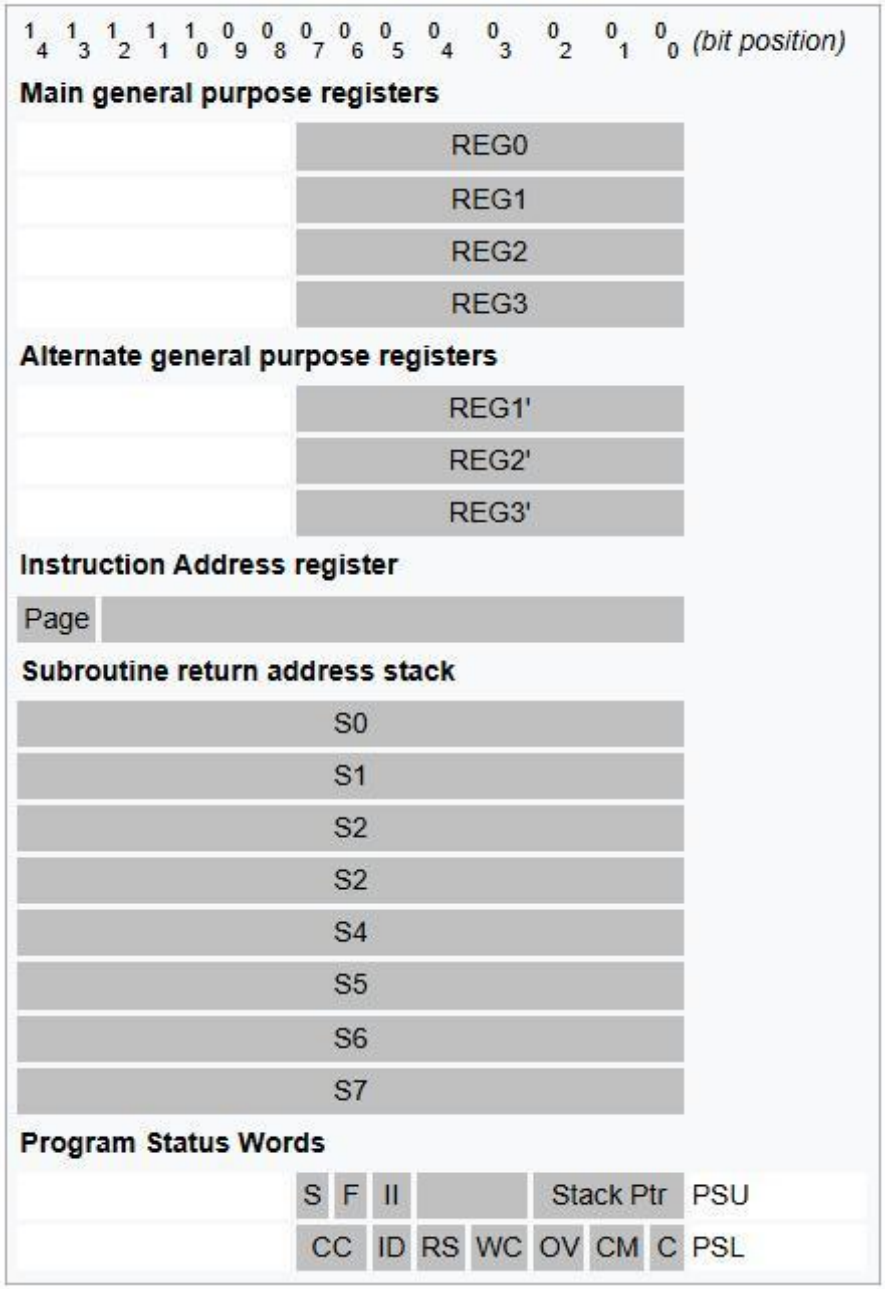


Figure 3: Signetics 2650 registers (from Wikipedia).

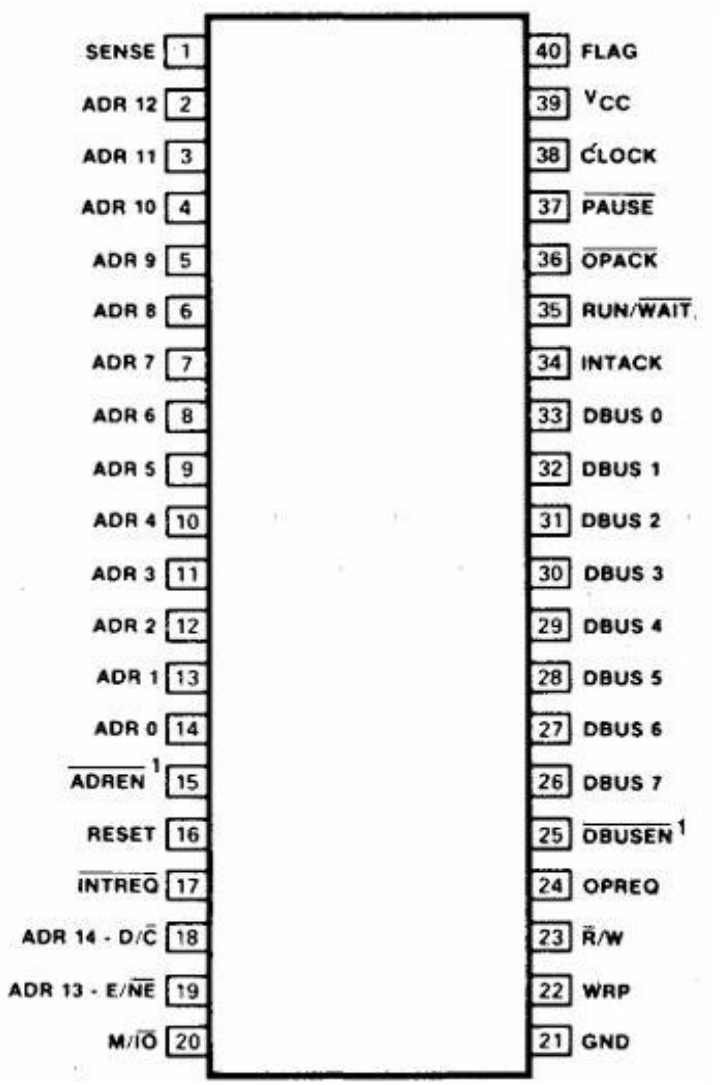


Figure 4: Signetics 2650 pinout (from Philips).

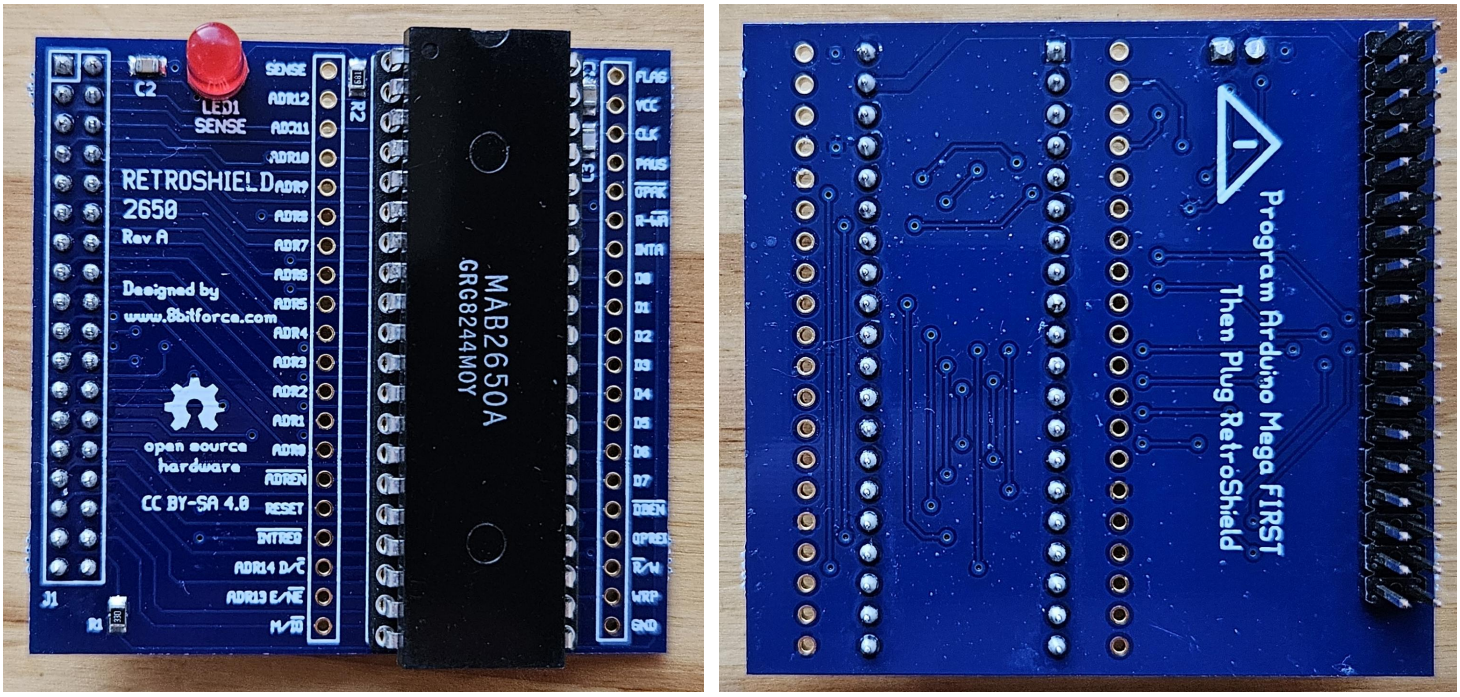


Figure 5: 8bitforce Retroshield 2650.

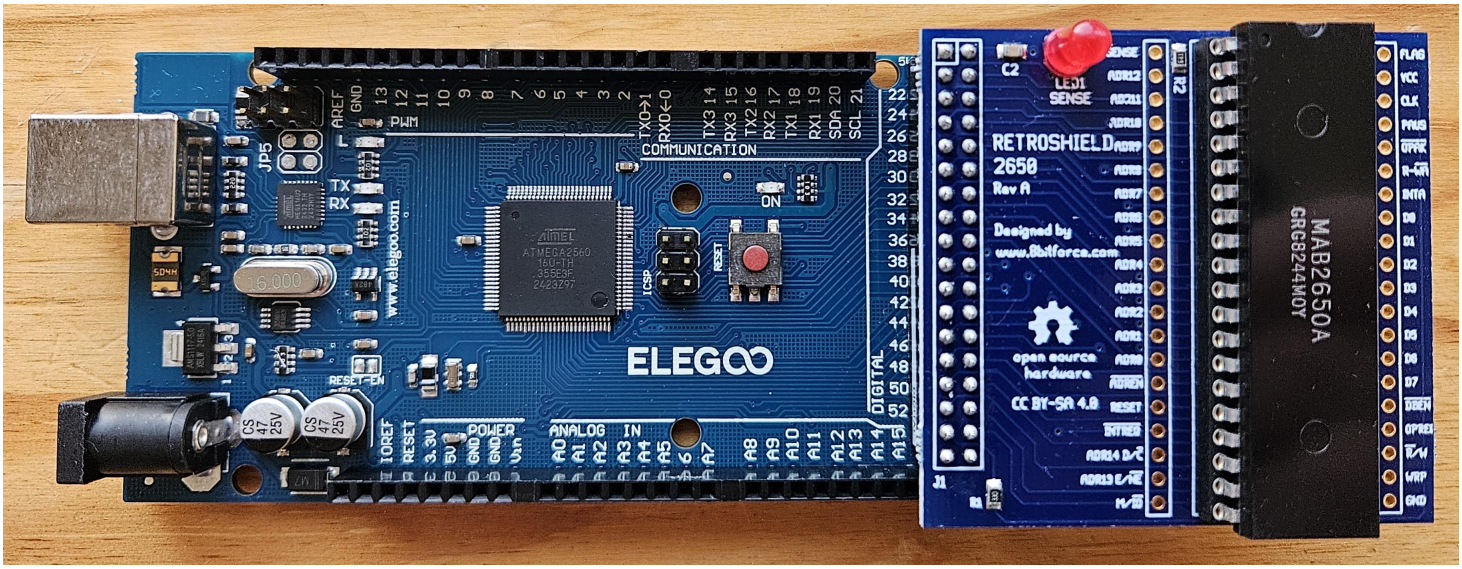
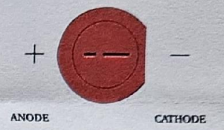
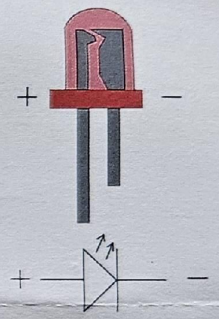


Figure 6: 8bitforce Retroshield 2650 coupled with Arduino Mega.

RetroShield 2650 Assembly Instructions
Rev A, 2019/12/21

LED (+) pin goes to square hole.

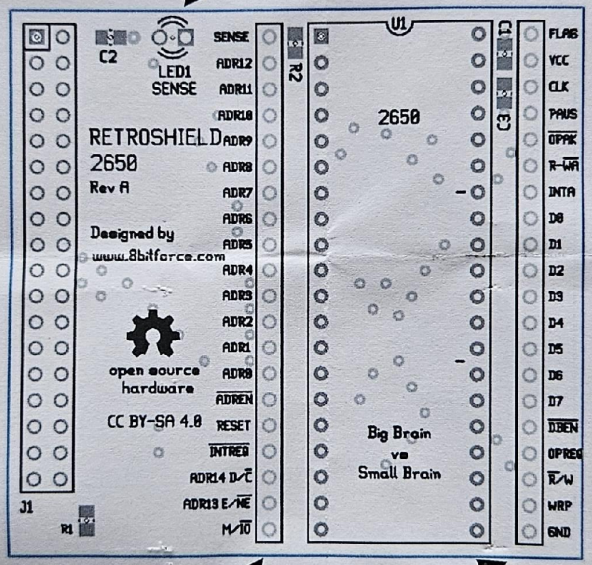




https://commons.wikimedia.org/wiki/File:%2B-_of_LED_2.svg

2650:
Solder parts in this order:
C1 = 100nF
C2 = 100nF
C3 = 22pF
R1 = 33 ohm
R2 = 680 ohm

U1 socket
J1 header
LED1 = Red



Probe points
If you want to attach headers, then be careful b/c access to SMD components will be difficult.

Figure 7: 8bitforce Retroshield 2650 assembly instructions.

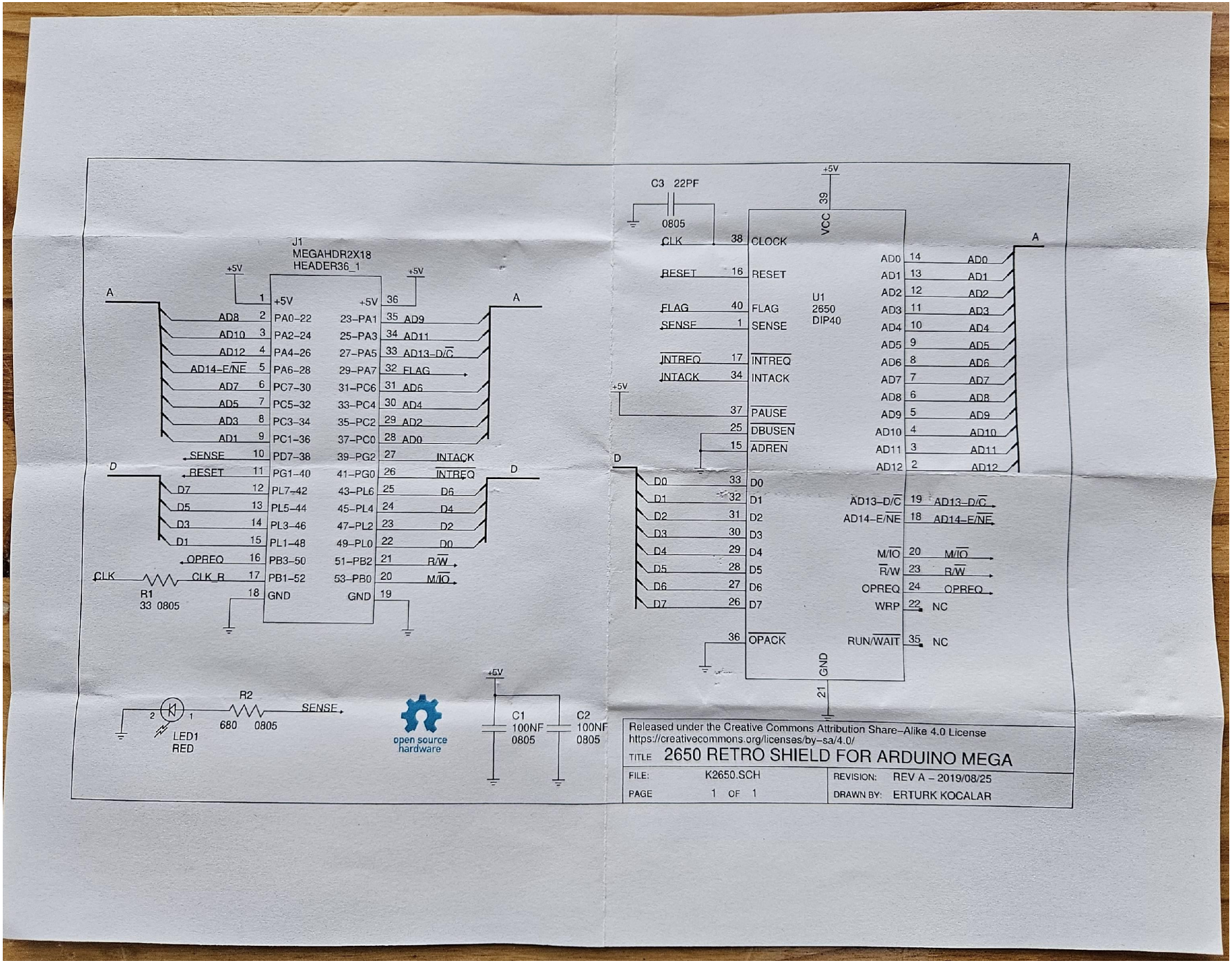


Figure 8: 8bitforce Retroshield 2650 schematic.