

AccessionIndex: TCD-SCSS-T.20251216.004

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Object name: Arduino shield for Intel 4040

Vintage: 2025

Synopsis: A board that enables execution of software by the 4040.

Description:

This Retrosshield 4040 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 4040 [2] is a daughter card that plugs into an Arduino Mega [3] or Teensy [4], see Fig.1. The Intel 4040 microprocessor [5] executes native 4040 code while the Arduino emulates 4040 system hardware. The choice of emulated 4040 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 4004 was the world’s first commercially successful microprocessor, designed by Federico Faggin, Masatoshi Shima, Ted Hoff and Stan Mazor. To improve on the 4004, and in order to overcome Intel’s preference for small/cheap dual-inline packages (DIP), which had constrained the 4004 to 16-pins, Faggin proposed an expansion of the 4004 to a modest 24-pins (Fig.3), formulated the architecture and led the project, supervising the detailed design by Tom Innes of what became the 4040 [5]. The extra pins enabled a doubling of the ROM space, interrupts (absent on the 4004), and halt/stop/single-step. The register set was roughly doubled and, the instruction set expanded from 46 to 60 (Fig.2). Even so, it retained backwards compatibility with the 4004 support chips. The 4040 was introduced in 1974, with an

extended chipset, and marketed as *MCS-40* [6]. The Retroschild 4040 is an updated version of that for the 4004, with two ZIF sockets, one each for the 4004 and 4040. Its design files are at [7].

The Retroschild 4040 can execute the native Busicom 141-PF Calculator code derived from the original ROMs, faithfully emulating ROM, RAM, spinning drum printer and keyboard [8]. The Retroschild 4040 software is at [9].

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

The homepage for this catalog is at: <https://www.scss.tcd.ie/SCSSTreasuresCatalog/>
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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.20251216.004	Arduino shield for Intel 4040. A board that enables execution of software by the 4040, 2025.
TCD-SCSS-T.20250916.001	Intel 4004 and 4040 microprocessors and associated chips. The first commercially successful microprocessors. 1971.
TCD-SCSS-T.20250916.002	Linux/4004 board. A replica of the board that hosted the epic first successful boot of Linux on the 4004, the first commercially successful microprocessor, 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:

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>
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4. PJRC, *Arduino Teensy*, see:
<https://www.pjrc.com/teensy/>
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5. Wikipedia, *Intel 4040*, see: https://en.wikipedia.org/wiki/Intel_4040
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6. Intel, *Intel MCS-40 User's Manual*, see:
<https://www.scss.tcd.ie/SCSSTreasuresCatalog/hardware/TCD-SCSS-T.20250916.001/MCS-40-Users-Manual-Nov74.pdf>
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7. Erturk Kocalar, *Retrosshield-HW Design Files*, see:
<https://gitlab.com/8bitforce/retrosshield-hw>
 Last browsed to on 18-Sep-2025.

8. Erturk Kocalar, *Retrosshield 4040 Source Code*, see:
<https://gitlab.com/8bitforce/retrosshield-arduino/-/tree/master/k4004>
Last browsed to on 18-Sep-2025.
9. Vintagecalculators, *The Calculator that spawned the Microprocessor: The Busicom 141-PF calculator and the Intel 4004 microprocessor*, see:
http://www.vintagecalculators.com/html/busicom_141-pf_and_intel_4004.html
Last browsed to on 16-Sep-2025.

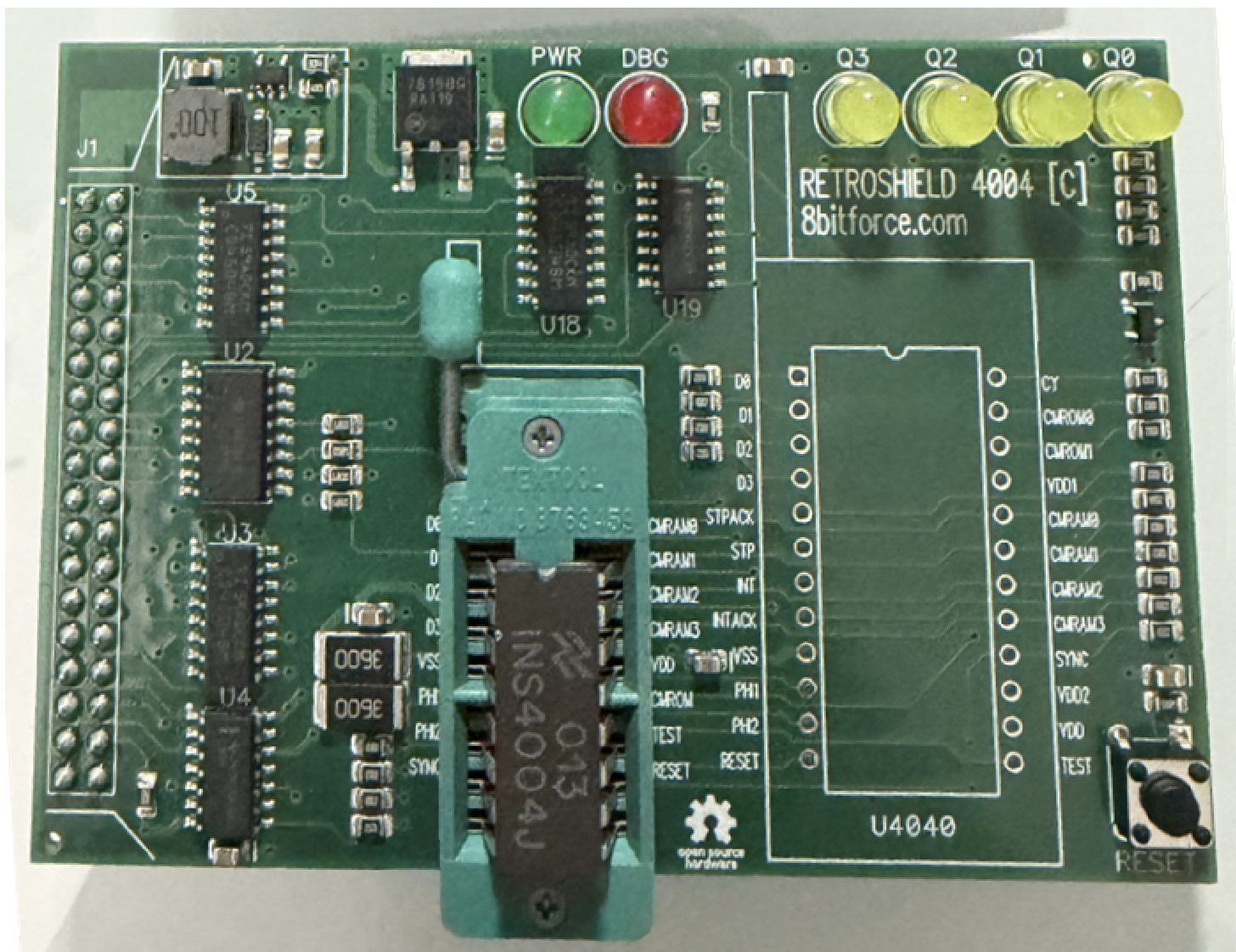


Figure 1: 8bitforce Retroschild 4040, able to host a 4004 or 4040.

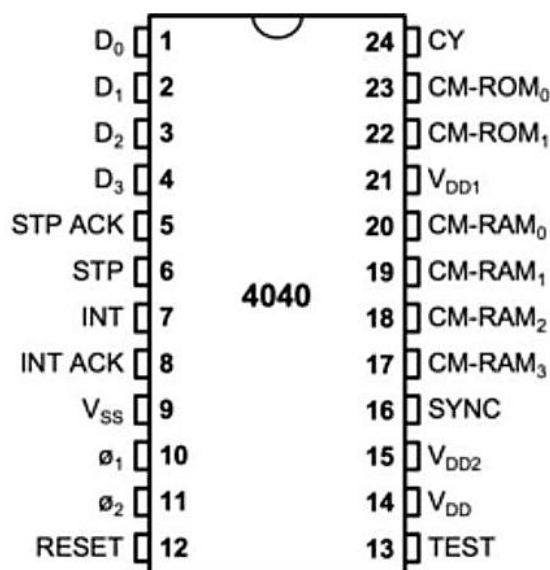


Figure 2: Intel 4040 pinout (from Wikipedia).

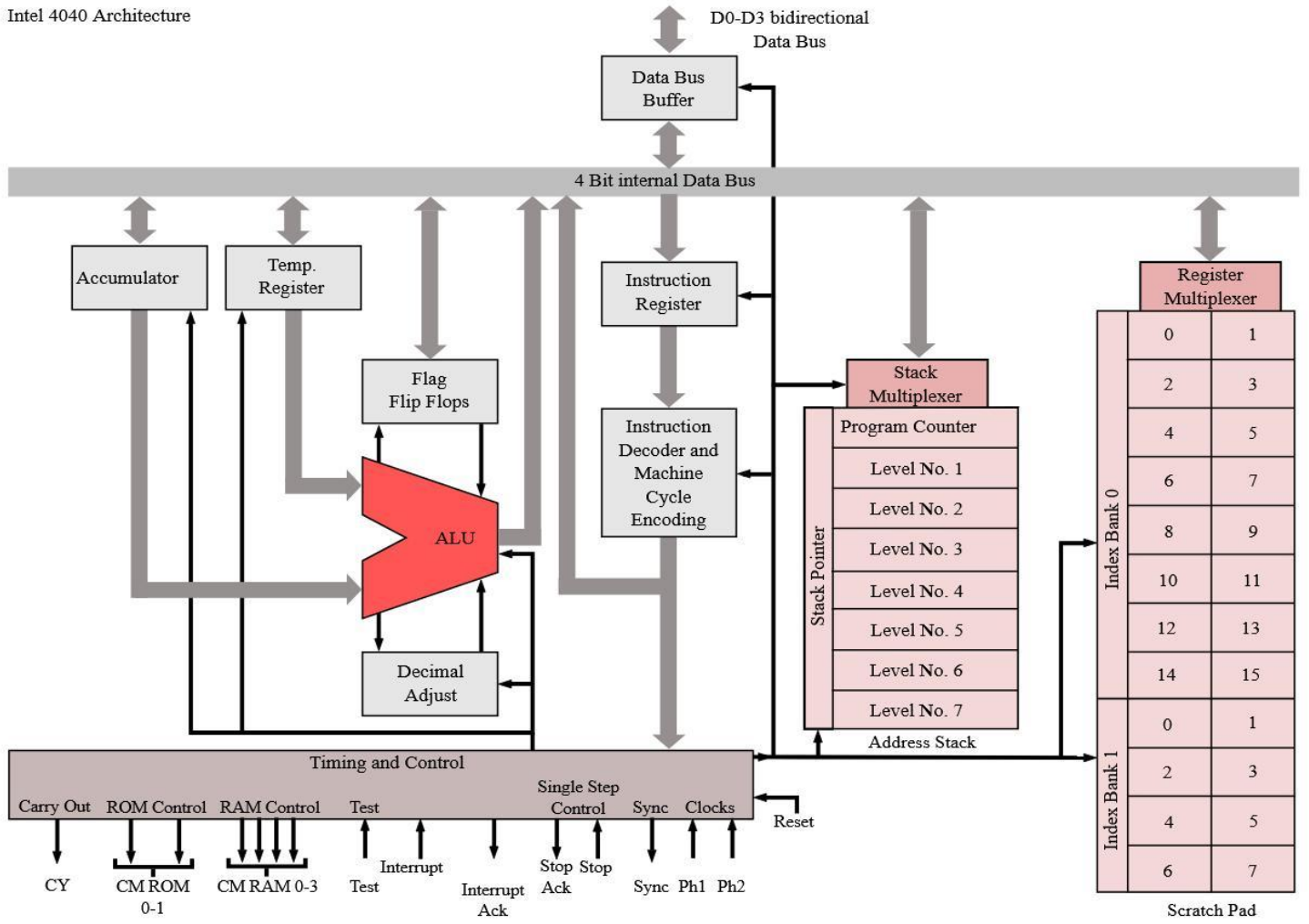


Figure 3: Intel 4040 registers (from Wikipedia).