

MOS Technology 6502

Architecture, Design, and Impact

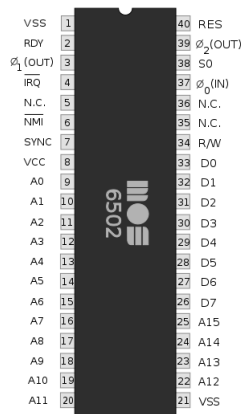
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MOS Technology 6502 Overview

- ▶ Released in 1975 in 40-pin DIP package.
- ▶ Competed directly with the Intel 8080 and Zilog Z80.
- ▶ Lead to rapidly decreasing prices in the microprocessor market.
- ▶ Widely popular in personal computer and system integration applications.
- ▶ MOS acquired by Commodore in 1976.
- ▶ Still used in embedded systems today.



Specifications

- ▶ 3 8-bit General Purpose Registers
- ▶ 8-bit Stack Pointer
- ▶ 8-bit Status Register
- ▶ 16-bit Program Counter
- ▶ 1 Edge-Triggered Non-Maskable Interrupt
- ▶ 1 Maskable Level-Sensitive Interrupt
- ▶ External Memory Address/Data Bus
- ▶ RDY output for Hardware Step-Through

History

- ▶ Chuck Peddle noticed Motorola customers were frustrated with high 6800 unit cost.
- ▶ Proposed a lower area, lower power, lower cost 6800 spin-off.
- ▶ New design leverages depletion-mode metal oxide semiconductor transistors.
- ▶ Frustrated by Motorola management, Peddle joins MOS Technology, who fund the 6502.
- ▶ 1975 saw a recession impact the silicon industry; 6502 sales flop as a result.

Beginnings of the Microcomputer

- ▶ To bolster sales, Peddle designs the MDT-650 single-board computer development platform.
- ▶ MDT-650 extremely popular with both engineers and hobbyists.
- ▶ Apple, Commodore, Atari, BBC capitalize on the emerging hobbyist/home computer market.
- ▶ Apple II, Commodore PET & VIC-20, BBC Micro, Atari 800 all designed around the 6502.



Home Game Consoles Emerge

- ▶ Ted Dabney and Nolan Bushnell begin investigating microprocessor-based video games.
- ▶ Unlike previous games based on dedicated discrete logic, microprocessor-based systems could play multiple games.
- ▶ Dabney and Bushnell realize that such a system would create it's own proprietary software market.
- ▶ “Stella” prototype adapted to use the low-cost 6502 in 1975.
- ▶ The Atari Video Computer System (later Atari 2600) was released in 1977.

6502 in the Japanese Market

- ▶ After success in the arcade game market, Nintendo decides to enter the personal computer market, work on the “Advanced Video System” begins.
- ▶ Management decides that the keyboard and terminal will discourage non-technophiles from purchasing the system; controllers are the only remaining interface in the final design.
- ▶ Engineers design a system around the cost-effective 6502, essentially unknown in Japan at the time.
- ▶ Obscurity of the 6502 in the Japanese market led Nintendo to produce it's own proprietary cross-development platform.
- ▶ The “Famicom” is released to critical acclaim in 1983.
- ▶ The NES is released in the US in 1985.
- ▶ Nintendo's unified development platform and licensing model is still used in the console market today.

6502 Implementation

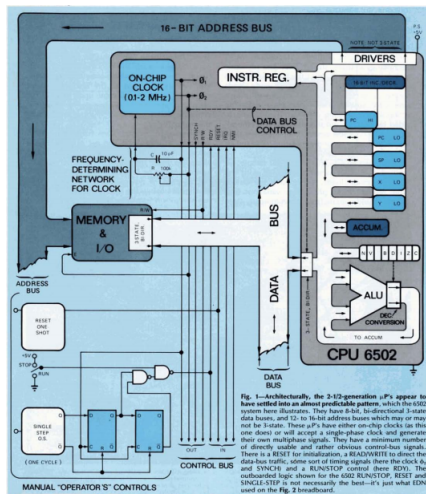
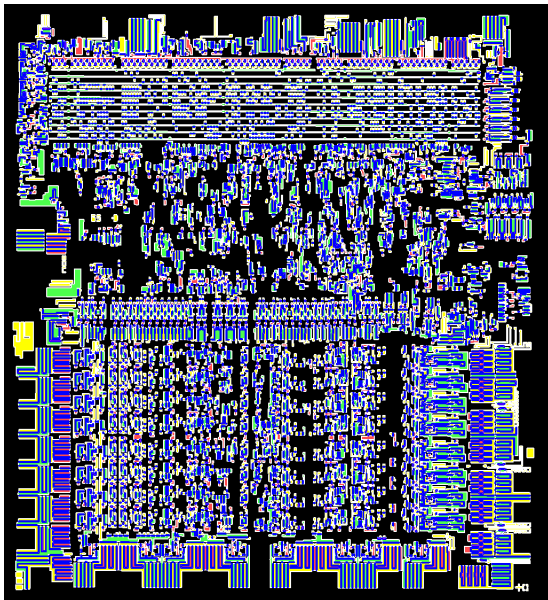


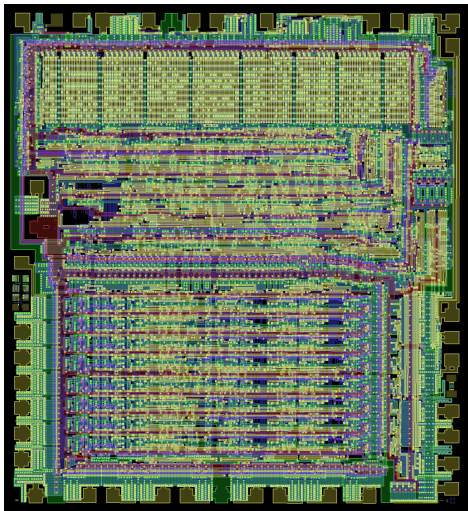
Fig. 1.—Architecturally, the 2-1/2-generation μ P's appear to have settled into an almost predictable pattern, which the 6502 system here illustrates. They have 8-bit, bi-directional 3-state data buses, and 12- to 16-bit address buses which may or may not be 3-state. These μ P's have either on-chip clocks (as this one does) or will accept a single-phase clock and generate their own multiphase signals. They have a minimum number of directly usable and rather obvious control-bus signals. There is a RESET for initialization, a READY/WRIT to direct the data-bus traffic, some sort of timing signals (here the clock ϕ_1 and SINCLOCK) and a RUN/STOP control (here RDY). The outboard logic shown for the 6502 RUN/STOP, RESET and SINGLE-STEP is not necessarily the best—it's just what EDN used on the Fig. 2 breadboard.

- ▶ 1-2 MHz typical clock frequency.
- ▶ Two synchronizations per cycle.
- ▶ Static PLA used for instruction decoding.
- ▶ 2-stage concurrent fetch pipeline.
- ▶ 3,510 total transistors.

6502 Polysilicon Diffusion Layers



6502 Layer Overlay



6502 Visualization:

<http://www.visual6502.org/JSSim/index.html>

Addressing Modes

- ▶ Absolute (Immediate Address)
- ▶ Branch-relative
- ▶ Zero Page
- ▶ Absolute/Zero-Page Indirection

