[Template:About](/wiki/Template:About" \o "Template:About)

[thumb|upright|An electronic pocket calculator with a](/wiki/File:SHARP_ELSIMATE_EL-W221.jpg) [LCD](/wiki/Liquid_crystal_display) [seven-segment display](/wiki/Seven-segment_display), that can perform arithmetic operations. [thumb|upright|A modern scientific calculator with a](/wiki/File:Casio-fx115ES-5564.jpg) [dot matrix](/wiki/Dot_matrix) LCD. An **electronic calculator** is a small, portable [electronic device](/wiki/Electronic_device) used to perform both basic operations of [arithmetic](/wiki/Arithmetic) and complex mathematical operations.

The first [solid state](/wiki/Solid-state_(electronics)) electronic calculator was created in the 1960s, building on the extensive history of tools such as the [abacus](/wiki/Abacus) (developed around 2000 BC), and the [mechanical calculator](/wiki/Mechanical_calculator) (developed in the 17th century AD). It was developed in parallel with the [analog computers](/wiki/Analog_computer) of the day.

The pocket sized devices became available in the 1970s, especially after the [first microprocessor](/wiki/Intel_4004) developed by [Intel](/wiki/Intel) for the Japanese calculator company [Busicom](/wiki/Busicom). They later became commonly used within the [Oil and Gas industry](/wiki/Petroleum_industry).

Modern [electronic](/wiki/Electronics) calculators vary: from cheap, give-away, [credit-card-sized](/wiki/ISO/IEC_7810) models to sturdy desktop models with built-in printers. They became popular in the mid-1970s (as [integrated circuits](/wiki/Integrated_circuit) made their size and cost small). By the end of that decade, calculator prices had reduced to a point where a basic calculator was affordable to most and they became common in [schools](/wiki/School).

Computer [operating systems](/wiki/Operating_system) as far back as [early Unix](/wiki/Ancient_UNIX_Systems) have included interactive calculator [programs](/wiki/Computer_program) such as [dc](/wiki/Dc_(computer_program)) and [hoc](/wiki/Hoc_(programming_language)), and calculator functions are included in almost all [PDA-type](/wiki/Personal_digital_assistant) devices (save a few dedicated address book and dictionary devices).

In addition to general purpose calculators, there are those designed for specific [markets](/wiki/Market_(economics)); for example, there are [scientific calculators](/wiki/Scientific_calculator) which include [trigonometric](/wiki/Trigonometry) and [statistical](/wiki/Statistics) calculations. Some calculators even have the ability to do [computer algebra](/wiki/Symbolic_computation). [Graphing calculators](/wiki/Graphing_calculator) can be used to graph functions defined on the real line, or higher-dimensional [Euclidean space](/wiki/Euclidean_space). Currently, basic calculators are inexpensive, but the [scientific](/wiki/Scientific_calculator) and [graphing](/wiki/Graphing_calculator) models tend to be higher priced.

In 1986, calculators still represented an estimated 41% of the world's general-purpose hardware capacity to compute information. This diminished to less than 0.05% by 2007.[[1]](#cite_note-1)

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## Design[[edit](/index.php?title=(none)&action=edit&section=1)]

[thumb|Scientific calculator displays of fractions and decimal equivalents.](/wiki/File:CalculatorFractions-5550x.jpg)

### Input[[edit](/index.php?title=(none)&action=edit&section=2)]

Modern 2016 [electronic](/wiki/Electronics) calculators contain a [keyboard](/wiki/Keyboard_(computing)) with [buttons](/wiki/Buttons) for [digits](/wiki/Numerical_digit) and [arithmetical](/wiki/Arithmetic) operations; some even contain "00" and "000" buttons to make larger or smaller [numbers](/wiki/Number) easier to enter. Most basic calculators assign only one digit or operation on each button; however, in more specific calculators, a button can perform multi-function working with [key combinations](/wiki/Key_combination).

### Display output[[edit](/index.php?title=(none)&action=edit&section=3)]

Calculators usually have [liquid-crystal displays](/wiki/Liquid-crystal_display) (LCD) as output in place of historical [light-emitting diode](/wiki/Light-emitting_diode) (LED) displays and [vacuum fluorescent displays](/wiki/Vacuum_fluorescent_displays) (VFD); details are provided in the section [*Technical improvements*](/wiki/#Technical_improvements).

Large-sized [figures](/wiki/Number) and [comma](/wiki/Comma) separators are often used to improve readability. Various symbols for [function commands](/wiki/Command_(computing)) may also be shown on the display. [Fractions](/wiki/Fractions) such as [Template:Math](/wiki/Template:Math) are displayed as decimal [approximations](/wiki/Approximations), for example rounded to [Template:Math](/wiki/Template:Math). Also, some [fractions](/wiki/Fraction_(mathematics)) (such as [Template:Math](/wiki/Template:Math), which is [Template:Math](/wiki/Template:Math); to 14 [significant figures](/wiki/Significant_figures)) can be difficult to recognize in [decimal](/wiki/Decimal) form; as a result, many [scientific](/wiki/Scientific_calculator) calculators are able to work in [vulgar fractions](/wiki/Vulgar_fraction) or [mixed numbers](/wiki/Mixed_number).

### Memory[[edit](/index.php?title=(none)&action=edit&section=4)]

Calculators also have the ability to store numbers into [computer memory](/wiki/Computer_memory). Basic types of these store only one number at a time; more specific types are able to store many numbers represented in [variables](/wiki/Variable_(mathematics)). The variables can also be used for constructing [formulas](/wiki/Formula). Some models have the ability to extend [memory](/wiki/Computer_memory) capacity to store more numbers; the extended [memory address](/wiki/Memory_address) is referred to as an [array](/wiki/Array_data_structure) index.

### Power source[[edit](/index.php?title=(none)&action=edit&section=5)]

Power sources of calculators are: [batteries](/wiki/Battery_(electricity)), [solar cells](/wiki/Amorphous_silicon#Solar_cells) or [mains electricity](/wiki/Mains_electricity) (for old models), turning on with a [switch](/wiki/Switch) or button. Some models even have no turn-off button but they provide some way to put off (for example, leaving no operation for a moment, covering [solar cell](/wiki/Solar_cell) exposure, or closing their [lid](/wiki/Lid_(container))). [Crank](/wiki/Crank_(mechanism))-powered calculators were also common in the early computer era.

### Key layout[[edit](/index.php?title=(none)&action=edit&section=6)]

|  |  |
| --- | --- |
| **Usual basic pocket calculator layout** | |
| |  |  |  |  | | --- | --- | --- | --- | | MC | MR | M- | M+ | | C | ± | % | ÷ | | 7 | 8 | 9 | × | | 4 | 5 | 6 | – | | 1 | 2 | 3 | + | | 0 | . | = | | |  |  | | --- | --- | | MC or CM | **M**emory **C**lear | | MR or RM | **M**emory **R**ecall | | M- | **M**emory **Sub**traction | | M+ | **M**emory **Add**ition | | C or AC | **A**ll **C**lear | | CE | **C**lear (last) **E**ntry; sometimes called CE/C: a first press clears the last entry (CE), a second press clears all (C) | | ± | Toggle positive/negative number | | % | [Per cent](/wiki/Percentage) | | ÷ | [Division](/wiki/Division_(mathematics)) | | × | [Multiplication](/wiki/Multiplication) | | – | [Subtraction](/wiki/Subtraction) | | + | [Addition](/wiki/Addition) | | . | [Decimal point](/wiki/Decimal_point) | | = | Result | |

## Internal workings[[edit](/index.php?title=(none)&action=edit&section=7)]

In general, a basic [electronic](/wiki/Electronics) calculator consists of the following components:[[2]](#cite_note-2)\* Power source ([Mains electricity](/wiki/Mains_electricity), [battery](/wiki/Battery_(electricity)) and/or [solar cell](/wiki/Amorphous_silicon#Solar_cells))

* [Keypad](/wiki/Keypad) (Input device) – consists of keys used to input numbers and function commands ([addition](/wiki/Addition), [multiplication](/wiki/Multiplication), [square-root](/wiki/Square_root), etc.)
* Display panel (Output device) – displays input numbers, commands and results. [LCDs](/wiki/Liquid-crystal_display), [VFDs](/wiki/Vacuum_fluorescent_display), and [LED displays](/wiki/LED_display) use [seven segments](/wiki/Seven-segment_display) to represent each [digit](/wiki/Numerical_digit) in a basic calculator. Advanced calculators may use [dot matrix](/wiki/Dot_matrix) displays.
  + A printing calculator, in addition to a display panel, has a printing unit that prints results in ink onto a roll of paper, using a printing mechanism.
* Processor [chip](/wiki/Chipset) ([microprocessor](/wiki/Microprocessor) or [central processing unit](/wiki/Central_processing_unit)).

|  |  |
| --- | --- |
| Processor chip's contents | |
| **Unit** | **Function** |
| Scanning ([Polling](/wiki/Polling_(computer_science))) unit | When a calculator is powered on, it scans the [keypad](/wiki/Keypad) waiting to pick up an [electrical signal](/wiki/Signal_(electrical_engineering)) when a key is pressed. |
| [Encoder unit](/wiki/Encoder) | Converts the [numbers](/wiki/Number) and [functions](/wiki/Function_(mathematics)) into [binary code](/wiki/Binary_code). |
| X [register](/wiki/Processor_register) and Y register | They are number stores where numbers are stored temporarily while doing calculations. All numbers go into the X register first; the number in the X register is shown on the display. |
| [Flag register](/wiki/Status_register) | The function for the calculation is stored here until the calculator needs it. |
| Permanent [memory](/wiki/Memory_(computers)) ([ROM](/wiki/Read_only_memory)) | The instructions for in-built functions ([arithmetic](/wiki/Arithmetic) [operations](/wiki/Operation_(mathematics)), [square roots](/wiki/Square_root), [percentages](/wiki/Percentage), [trigonometry](/wiki/Trigonometry), etc.) are stored here in [binary](/wiki/Binary_number) form. These instructions are "[programs](/wiki/Computer_program)", stored permanently, and cannot be erased. |
| User memory ([RAM](/wiki/Random_access_memory)) | The store where numbers can be stored by the user. User memory contents can be changed or erased by the user. |
| [Arithmetic logic unit (ALU)](/wiki/Arithmetic_logic_unit) | The ALU executes all [arithmetic](/wiki/Arithmetic) and [logic](/wiki/Boolean_algebra) [instructions](/wiki/Instruction_(computer_science)), and provides the results in [binary coded](/wiki/Binary-coded_decimal) form. |
| [Decoder unit](/wiki/Binary_decoder) | Converts [binary code](/wiki/Binary_code) into "[decimal](/wiki/Decimal)" numbers which can be displayed on the display unit. |

[Clock rate](/wiki/Clock_rate) of a processor [chip](/wiki/Chipset) refers to the frequency at which the [central processing unit](/wiki/Central_processing_unit) (CPU) is running. It is used as an indicator of the processor's speed, and is measured in *clock cycles per second* or the [SI](/wiki/International_System_of_Units) unit [hertz (Hz)](/wiki/Hertz). For basic calculators, the speed can vary from a few hundred [hertz](/wiki/Hertz) to the [kilohertz](/wiki/Kilohertz) range. [thumb|upright|An office calculating machine with a paper printer.](/wiki/File:Tischrechner_Walther_ETR2034S_resized.jpg)

### Example[[edit](/index.php?title=(none)&action=edit&section=8)]

A basic explanation as to how calculations are performed in a simple 4-function calculator:

To perform the calculation 25 + 9, one presses keys in the following sequence on most calculators: [Template:Key press](/wiki/Template:Key_press) [Template:Key press](/wiki/Template:Key_press) [Template:Key press](/wiki/Template:Key_press) [Template:Key press](/wiki/Template:Key_press) [Template:Key press](/wiki/Template:Key_press).

* When [Template:Key press](/wiki/Template:Key_press) [Template:Key press](/wiki/Template:Key_press) is entered, it is picked up by the scanning unit; the number 25 is encoded and sent to the X register;
* Next, when the [Template:Key press](/wiki/Template:Key_press) key is pressed, the "[addition](/wiki/Addition)" instruction is also encoded and sent to the [flag register](/wiki/Status_register);
* The second number [Template:Key press](/wiki/Template:Key_press) is encoded and sent to the X register. This "pushes" (shifts) the first number out into the Y register;
* When the [Template:Key press](/wiki/Template:Key_press) key is pressed, a "message" (signal) from the [flag register](/wiki/Status_register) tells the [permanent memory](/wiki/Non-volatile_memory) that the operation to be done is "[addition](/wiki/Addition)";
* The numbers in the X and Y registers are then loaded into the [ALU](/wiki/Arithmetic_logic_unit) and the calculation is carried out following instructions from the [permanent memory](/wiki/Non-volatile_memory);
* The answer, 34 is sent (shifted) back to the X register. From there, it is converted by the [decoder](/wiki/Binary_decoder) unit into a decimal number (usually [binary-coded decimal](/wiki/Binary-coded_decimal)), and then shown on the display panel.

Other functions are usually carried out using repeated additions or subtractions. Subtractions are usually carried out by using [two's-complement](/wiki/Two's-complement) operations. Where calculators have additional functions (such as square root, or trigonometric functions), software [algorithms](/wiki/Algorithm) are required to produce high precision results. Sometimes significant design effort is required to fit all the desired functions in the limited memory space available in the calculator [chip](/wiki/Chipset), with acceptable calculation time.[[3]](#cite_note-3)

## Calculators compared to computers[[edit](/index.php?title=(none)&action=edit&section=9)]

[Template:Unreferenced section](/wiki/Template:Unreferenced_section) The fundamental difference between a calculator and [computer](/wiki/Computer) is that a computer can be [programmed](/wiki/Computer_programming) in a way that allows the [program](/wiki/Computer_program) to take different [branches according to intermediate results](/wiki/Branch_on_condition), while calculators are pre-designed with specific functions (such as [addition](/wiki/Addition), [multiplication](/wiki/Multiplication), and [logarithms](/wiki/Logarithm)) built in. The distinction is not clear-cut: some devices classed as [programmable](/wiki/Programmable_calculator) calculators have [programming](/wiki/Computer_programming) functionality, sometimes with support for [programming languages](/wiki/Programming_language) (such as [RPL](/wiki/RPL_programming_language) or [TI-BASIC](/wiki/TI-BASIC)).

Typically, the user buys the least expensive model having a specific feature set, but does not care much about speed (since speed is constrained by how fast the user can press the buttons). Thus designers of calculators strive to minimize the number of logic elements on the [chip](/wiki/Chipset), not the number of [clock cycles](/wiki/Clock_cycles) needed to do a computation.

For instance, instead of a hardware multiplier, a calculator might implement [floating point](/wiki/Floating_point) mathematics with code in [ROM](/wiki/Read-only_memory), and compute [trigonometric](/wiki/Trigonometric_functions) functions with the [CORDIC](/wiki/CORDIC) algorithm because [CORDIC](/wiki/CORDIC) does not require hardware floating-point. [Bit serial](/wiki/Bit_serial) logic designs are more common in calculators whereas [bit parallel](/wiki/Bit_parallel) designs dominate general-purpose computers, because a bit serial design minimizes [chip](/wiki/Chipset) complexity, but takes many more [clock cycles](/wiki/Clock_cycles). (Again, the line blurs with high-end calculators, which use processor chips associated with computer and embedded systems design, particularly the [Z80](/wiki/Z80), [MC68000](/wiki/MC68000), and [ARM](/wiki/ARM_architecture) architectures, as well as some custom designs specifically made for the calculator market.)

## History[[edit](/index.php?title=(none)&action=edit&section=10)]

### Precursors to the electronic calculator[[edit](/index.php?title=(none)&action=edit&section=11)]

[Template:Main article](/wiki/Template:Main_article) [Template:See also](/wiki/Template:See_also)

The first known tools used to aid arithmetic calculations were: bones (used to tally items), pebbles and [counting boards](/wiki/Counting_board), and the [abacus](/wiki/Abacus), known to have been used by [Sumerians](/wiki/Sumer) and [Egyptians](/wiki/Ancient_Egypt) before 2000 BC.[[4]](#cite_note-4) Except for the [Antikythera mechanism](/wiki/Antikythera_mechanism) (an "out of the time" [astronomical](/wiki/Astronomy) device), development of computing tools arrived near the beginning of the 17th century: the [geometric-military compass](/wiki/Sector_(instrument)) (by [Galileo](/wiki/Galileo_Galilei)), [logarithms](/wiki/Logarithm) and [Napier bones](/wiki/Napier_bones) (by [Napier](/wiki/John_Napier)), and the [slide rule](/wiki/Slide_rule) (by [Edmund Gunter](/wiki/Edmund_Gunter)).

[thumb|17th century mechanical calculators.](/wiki/File:17th-century-mechanical-calculators.jpg) In 1642, the [Renaissance](/wiki/Renaissance) saw the invention of the [mechanical calculator](/wiki/Mechanical_calculator) (by [Wilhelm Schickard](/wiki/Wilhelm_Schickard)[[5]](#cite_note-5)