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Motor vehicles are now inconceivable without electronic control units and their associated sensors and actuators. Such components have revolutionised the automotive world. All essential vehicle functions are electronically controlled by systems and components that occupy only a tiny space. There are systems that control the function of engine and gearbox, the safety and security systems and a large number of comfort and convenience systems, and the number of "intelligent" vehicle systems is growing at a rapid pace. Nor is there any foreseeable end to this trend.

Electronic control systems open the door to a vast array of possibilities. They improve vehicle safety and ride comfort. At the same time, they make vehicles more economical and kinder to the environment.

The triumphant advance of electronics has created a vocabulary of terms with which we are bombarded every day. It is becoming more and more difficult to understand what precisely those terms refer to.

This publication in the Bosch Yellow Jacket "Technical Instruction" series explains the specialist terminology of microelectronics in detail.

It starts with a short introduction followed by an explanation of the principles of semiconductor technology and how microelectronic components interact. A practical example of a circuit helps to consolidate the theoretical concepts described. This is then followed by a description of the development and production of control units.

Finally, the glossary provides a quick guide to the most important microelectronics terms.

The functions of the individual electronic systems (e.g. MED, EDC, ESP) are described in detail in separate publications in the Yellow Jacket "Technical Instruction" series.

Microcontroller components

The microcontroller is a programmable electronic module that contains all the necessary components for a microcomputer system. It consists of the

- *CPU,*
- the *memories* for instructions (program memory) and data (data memory), and
- the *peripheral modules.*

Those components exchange data and monitoring information via bus links (Fig. 1).

CPU

The CPU (**c**entral **p**rocessing **u**nit; also referred to as the microcontroller core) is the programmable unit for addressing and manipulating data and for controlling the timing and logical sequence of a program.

Memory

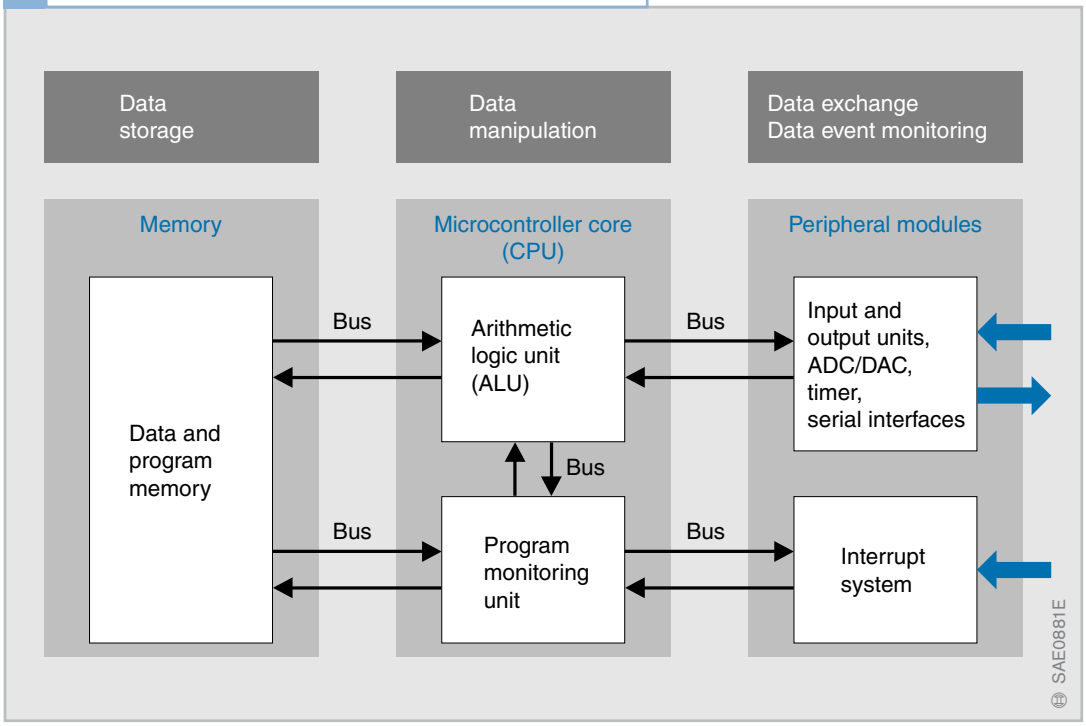
The memory is used to store data and program instructions. The memory for variable data is a random-access memory (RAM). The memory used for program instructions and unvarying data is a read-only memory (e.g. ROM or PROM). In addition, microcontrollers have a small register memory integrated in the CPU for rapid access (cache memory).

Peripherals

The peripherals are used for the input and output of data originating from or destined for external systems. The peripherals are programmable to a limited degree in order that their functions are adaptable to the requirements of the application.

Typical peripheral modules digitise analog external signals or convert internal digital signals into analog signals for output (analog-digital and digital-analog converters). Counters and timers count external pulses and time intervals between events. Communication interfaces are used for the exchange

1 Structure of a microcontroller with the “Von-Neumann architecture”



of data with other modules via standardised bus links (e.g. CAN bus).

There are, of course, many other functions that can be integrated in the microcontroller depending on the requirements of the user concerned.

Main operations

The three blocks illustrated in Figure 1 enable the four main operations of the microcontroller, i.e.

- data manipulation (data processing),
- data storage,
- data exchange with external systems (data movement), and
- data event monitoring (control mechanism).

These functions enable the microcontroller to be used to transfer, store and manipulate data (both in the memory and externally). The sections which follow describe the various modules of the microcontroller that make those operations possible.

Design and operating concept

CPU (Central Processing Unit)

The CPU processes the data received from external sources via the peripherals and monitors the data flow. In the CPU there is a small memory (register) in which operands, results and addresses are stored. Figure 2 shows the basic structure of a CPU, which may also be extended by additional components in order to increase the processing speed.

Programming model

The "programming model" of a microcontroller refers to the sum total of all registers that are available to, i.e. are "visible" to, the programmer. In principle, there does not have to be any "visible" register in the CPU. But in that case, every alteration to the program would necessitate modification of the hardware, which would be very involved, expensive and time-consuming. Rarely altered configurations are therefore set by means of bits in special control registers. The control

2 Basic structure of a CPU (microcontroller core)