

## Application of Microprocessor in the Testing

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**Abstract.** The microprocessor gradually plays a core role in the modern industry and has a wide application field such as remote sensing, data acquisition, temperature control, speech recognition, dynamic detection, real-time monitoring. Application of microprocessor in the industrial test field has three aspects: 1) Hand-held test instrument; 2) Test system based on universal micro computer; 3) Application of large test platform and Super Computer. With the progress of the times, the technical field of microprocessor will face new opportunities and challenges. And there is no doubt that microprocessor will drive the other disciplines to have common development.

Computer has been widely used in all aspects of human life since twenty-first century. It has become one of the most important tools in daily life. The microprocessor, the core of micro-computer, has developed as the times pass by. In the field of modern industry, most of the test system cannot do without the microprocessor, especially in the highly complicated and sophisticated test platform. The microprocessor, short for  $\mu\text{P}$  or MP, is the core chip of micro computer<sup>[1]</sup>. It integrates the arithmetic unit and controller of the computer on a silicon chip, also known as the central processor(CPU). The microprocessor is one of the most important innovations in 1970s. Moreover, it has achieved a great achievement after forty years development. Moore's law and Baer's law shows<sup>[2]</sup>: microprocessor transistor integration is doubling every 18 months; the prices of microprocessor cuts down by half every 18 months under the condition of constant calculation ability of computer. Since the two major laws put forward, the development of computer has always followed them, and it is true that the performance of microprocessor is also increasing.

The world's first chip microprocessor is Inter4004 which was designed by Inter in 1971. It was a four bit microprocessor ,also known as the first generation microprocessor. The instruction system of the first generation microprocessor is relatively simple, the operation ability weak and the arithmetic speed low (The basic instruction execution time is 10-20 $\mu\text{s}$ ). The main programming language is machine language and simple assembly language. Second generation, named Inter8080 which is another 8 bit microprocessor, is designed by Inter company on the basis of 8008. This is an epoch-making product, because it is the first truly practical microprocessor. It memory addressing space increases to 64KB and extends instruction set. What's more, it instruction execution rate reaches 0.5MIPS, more than 8008 ten times faster. In addition, it makes CPU external circuit design easier and reduces the cost. Third generation microprocessor is developed based on the successful development of very large scale intergrated circuit, such as 8086 and 8088 designed by Inter. The 16 bit microprocessor is increased by about one order of magnitude than the 8 bit microprocessor integration, greatly increased functionality. The 16 bit microprocessor has the advantage of addressing space larger, more computing power, faster speed and better instruction system. Then with the progress of science and technology, the microprocessor has been developed to the seventh generation and continues to have a very good development. In a word, according to the information processing word length, the development direction of the microprocessor is 8-bit microprocessor, 16-bit microprocessor, 32-bit microprocessor, 64-bit microprocessor and the latest multi-core microprocessor<sup>[3]</sup>. With the development of microprocessor, the computation power increases significantly, the power consumption reduces gradually, the transistor integrated quantity and clock frequency increases significantly, and the overall performance is gradually increasing.

Application of microprocessor in the field of testing is quite broad. The number of personnel engaged in the related scientific research is large and the achievements are remarkable. There are

more than ten thousand papers about the application of microprocessor in the test domain on China HowNet in the last two years since 2013. Most of those papers choose appropriate microprocessor to finish the specified testing tasks. With the continuous development of science and technology and the form of war by mechanization to informationization, weaponry becomes informationization, digitization, automation, integrated and complex. The characteristics of high technology content of weapon equipment makes its testability and maintainability become more and more difficult, and it obviously promotes the change of security mode. The key technology is the measuring equipment state information collection and analysis of key data. Data processing and analysis is to get the technology condition of test equipment of description information by the processing of the corresponding software. The purpose is to help provide the necessary technical guarantee for the equipment operating personnel and service personnel. All aspects of security equipment repair such as test system and processing data cannot do without the microprocessor.

The main application aspects are: remote sensing, data acquisition, temperature control, speech recognition, dynamic detection, real time monitoring and so on. Here focuses on the following three respects:

#### **Hand-held testing instrument.**

In today's society, more and more forms of the test object appear, the testing conditions become more complex and the requirement of testing method becomes more and more simple. However, more and more hand-held instruments are required. The main characteristics of hand-held instrument are: portable, low power consumption, the storage and display of collection data and essential communication ability. Portable is the most basic requirement, that is, the quick and simple testing can be done under an appropriate testing precision. What's more, the development of battery gets a very big restriction. For example, problem of fast charge has not yet been resolved. Therefore, the lower power consumption of microprocessor is, the better the system is. This can not only increase the use of time, but also simplify the design of the radiating device and increase reliability. Necessary communication ability is also very important. Test equipment with communication ability is helpful to realize the real-time dynamic monitoring and control the system. It will be an important future development direction to combine modern intelligent mobile phone. Hand-held instrument has a very wide application. Multimedia is the most typical hand-held instrument which can test, display and do other tasks. The main applications of hand-held instrument are alcohol concentration tester in traffic, hand-held ultrasonic depth meter, high frequency signal testing instrument and so on.

#### **General testing system based on microcomputer.**

In the industrial testing system, a large part of the testing platform is built on microcomputer. In this testing system, the microcomputer is the core. In other words, microcomputer is not only the data acquisition, storage, display, processing platform, but also the communication and human-computer interaction platform. Therefore, the performance of microprocessor is related to the testing object, as well as related to the information processing and display mode. Fault diagnosis system for the gear box case is as an example. The test is to get the characteristic information of the measured object by the vibration sensor. Then it transfers the data to computer by bus technology and also displays, stores and other functions. Usually, the testing system includes hardware system and software system, but there is a saying that software is instrument in virtual instrument. There is no doubt that software plays an important role in testing system. Application of microprocessor performance is closely related to the large specific software. That is to say, software has a large effect on microprocessor's selection. The requirements of microprocessor in the testing system are: First, the microprocessor can strongly support real-time multitasks so as to perform multiple tasks. At the same time, it possesses short interrupt response time to reduce the interior of the code and the execution time of real-time kernel to a minimum. As we all know, general testing systems can only perform a single task and it certainly will cause a great waste of resources. So one of the important contents of microcomputer testing system is to complete multitasks. Second, the microprocessor has strong storage protection function. In order to avoid the cross interaction errors between the software modules, it needs to design the strong protection function. It is also good to diagnose software. For example, in the characteristics of

wheel/rail noise detection algorithm design and experimental study, the same micro computer must run a lot of engineering software like Matlab and Labview. To ensure the normal operation of all software is a basic requirement for microprocessor. Third, extensible structure of the microprocessor can be quickly extended, thus meeting the high performance microprocessor. Fourth, the requirement of power consumption is low.

### **Application of large testing platform and Super Computer.**

Large testing platform has a wide range of application in industry and military. Such as, the German Mueller BBM designs a dynamic measurement system, named Multi Chassis System Integration. This system employs a specific workstation computer to control the integrated testing system and to manage data acquisition, transmission, storage and so on. Because of 1968 channels and 70M/s transmission speed, it can guarantee the stable operation of the system. Single chassis, adopting a wireless transmission mode and computer communication at maximum transmission speed of 600k/s, is mainly appropriate for the conditions that conventional wired transmission data can not be used. For example, due to the relative motion between the tire and the ground when a car processes, it can not get internal noise and road noise simultaneously. The distance of the wireless transmission is 200 meters. The method of realizing synchronous acquisition is that each case shares the standard GPS time at data collecting. This requires high performance microprocessor, such as real-time response, immediate processing, large storage ability and necessary communication ability. Meanwhile, the super computer is mainly used to undertake the large computing subjects and data processing tasks at the field of important scientific researches, national defense sophisticated technology and national economy. Application examples are as following: forecasting weather, arranging the satellite images, exploring nuclear physics, researching intercontinental missile and spacecraft and so on[5,7,8]. Super computer will be necessary to make plans for national economy development, which has the characteristic of various items, timeliness and considering different factors. And this requires higher performance microprocessor to accomplish such difficult tasks.

Nowadays, general architecture of microprocessor is facing new challenges and innovation opportunities. On the one hand, integrated circuit will still keep high speed to develop Moore's law. On the other hand, with the rapidly development of network technology, mobile computing and cloud computing has become very important calculation models. This two kinds of calculation modes make the microprocessor urgent to fit real-time response, ability to deal with streaming data, support of data level and thread level parallel, higher I/O bandwidth and storage and low power consumption. In recent years, by the scientific efforts of research workers, there are a lot of new architecture microprocessor. The representative development trends are Multi-core Processing, Stream Processor, Processor in Memory and Reconfigurable Processor and so on<sup>[6]</sup>.

The development trends of testing system of microprocessor are put as the following several aspects. Firstly, network connection of the testing system. The new era of human science research is to build a physical connection of intelligent network which is an essential part. The network helps to collect more resources, fast judge the fault diagnosis and easily complete fault location. The most important research is to realize the network connection with microprocessor. Secondly, standardized design of the testing system. Higher sophisticated device and system require the corresponding testing system that is difficult to design and costs more money and time. It can solve these problems easily if general testing system and standard equipment are used. Thirdly, standardization of the testing system will improve the portability and interoperability of the testing program. In order to realize this advantage, there must be two conditions which are standard signal interface and the test program unrelated to hardware. It is true that this kind of microprocessor will become the mainstream of the market in the future.

As the science and technology advance, the microprocessor in the testing system is used more and more widely, and it certainly will greatly improve its performance. The direction of electronic information product is digitization, intelligentize, and networking. The research and development of the microprocessor is full of opportunities and challenges. Accordingly, it will promote the common development and prosperity of other subjects.

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