

Miniaturized Electronics: Advantages, Disadvantages and its Applications

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ABSTRACT:

Miniaturization is a fast-growing methodology that is way to produce very small electronic, mechanical and optical products and devices which includes computers, semiconductor chips, sensors, bio-sensors, ICs and microprocessors built-in vehicles and many more. Now a days, one can see small and portable devices which can be carried out in pocket to anywhere at any time, the reason behind this is the technology that give the flexibility to miniaturize the components with number of advantages and applications. Not only in the Electronics gadgets, Miniaturization is playing an important role in advancement in nanotechnologies that have made it possible to fabricate great variety of structures with special features and properties. The small size and lightweight are benefits of hybrid microcircuits; they have used for long time in pacemakers' defibrillators, hearing aids, flexible polyimide structures and many more applications. Miniaturization and integration of portable devices have been achieved so remarkably day by day that wearable computing is being realised. Here, in this work efforts are made to understand the concept of Miniaturization, its advantages, disadvantages and applications

KEYWORDS: Miniaturization, microprocessors, built-in vehicles, bio sensors

INTRODUCTION:

Miniaturization has been particularly important to many of technological advances. On-going trend towards this ever smaller optical and mechanical

and electronic devices are becoming increasingly popular. Various processes associate with semiconductor device and circuit technology like electronic packaging; so that it forms the backbone of high performance miniaturised electronic system. At present miniaturized electronics is a key promoter for technology, devices and business reaching from bottom level testing to the development of satellites, astronomical robotics and interplanetary spacecraft [1]. The basic terminology [2] of miniaturized circuit is integrated circuits (ICs). To understand the concept of miniaturization, we have to explore the broad area of ICs and electronic packaging which consist of developing transistors and capacitors on it.

INTEGRATED CIRCUITS:

An IC is a collection of discrete electronic components such as resistor, capacitor and transistor etc all stuffed into a tiny chip, and connected together to achieve a common goal. They come in all sort of flavours: single circuit logic gates, op-amps, 555 timers, voltage regulators, motor controllers, micro controllers and microprocessors and many more as per the requirement of the user. On the behalf of this, in 1965, Gordon E. Moore, the co-founder of Intel made a special observation called Moore's Law [3-5]. It states that the number of transistors on the micro-chip doubles about every two years, though the cost of computer is half, depending on device technology. Due to the uncertainty principle along, Moore's Law will be obsolete by 2050-55 as seen on graph in Figure-1[5]:

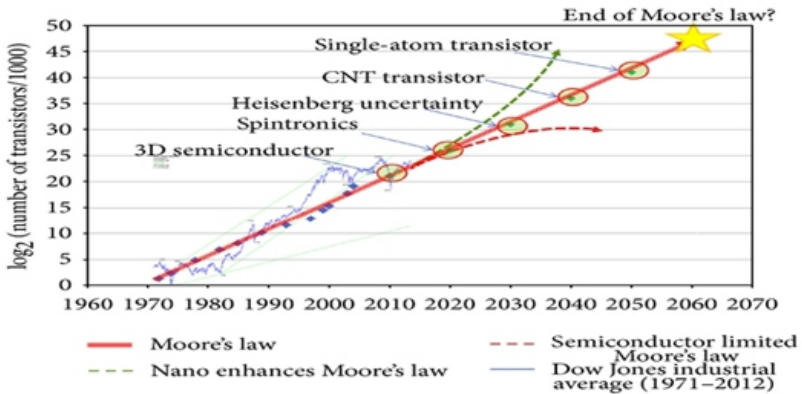


Figure -1. Moore's Law reflecting the exponential growth in transistor on a single chip.

As the IC technology and its performance is expanding day by day beyond its boundaries, the concept of IC packaging was introduced. Basically, it is the methodology for connecting and interfacing the IC technology with system and physical world which makes it advantageous over old concept IC. The demand of IC packaging is increasing rapidly by the ICs and end-use system applications because of which the electronic packaging world is undergoing intense changes and trying to keep pace with demand.

ADVANTAGES OF MINIATURIZATION:

Miniaturized electronic has a broad space in technology having many advantages. Some of them are:

Small Size- For the past few decades, the competition of smaller, handheld, wearable or portable electronic devices is going on in various markets such as Aerospace, Media Consumer Electronics and Stringet Medical Industry. Miniaturization of electronic subassemblies can free up space to allow the incorporation of larger batteries without increasing the overall size of device, something which appeals to end users in almost every sector. From an aesthetic view point, smaller modules give designers greater freedom to produce stylish products with enhanced consumer appeal also from a technical view point smaller modules mean shorter signal path with less stray inductance and capacitance, so integrity of signal in improved and high operating speed would be reliably achieved. For example, the smallest satellite as shown in figure-2[6] called as KalamSathas successfully launched. It is the world's smallest and lightest satellite which is lighter than a smart phone.

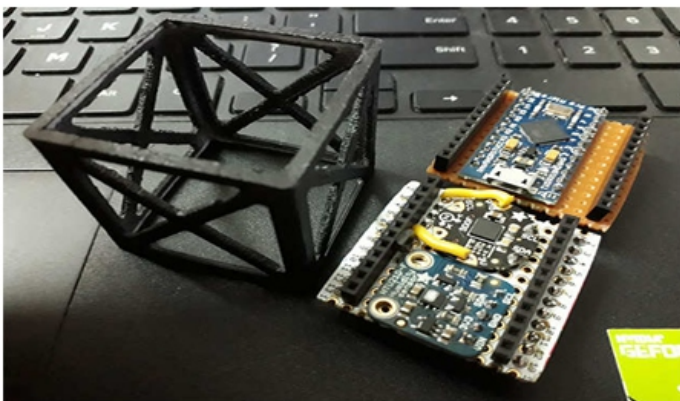


Figure 2. World's smallest working satellite which is of 64 grams.

Cost- Cost always plays a major role in any sector. Due to the elimination of components such as resistor capacitor and inductors decreases the costs as well as the required space, points such that the design-in, the assembly, the visual and functional inspection of the solder point incurs cost that sometime exceed the cost of components itself. Assume the world with old style vacuum tubes. Then, a 1 T-bit(128 GB)memory need 1 trillion vacuum tubes which would cost 1 trillion US dollars which is a very huge amount [7]. By miniaturization the downsizing of electron devices has make possible to improve the cost and performance. At present, 1 T-bit (128 GB) SD card composed of semiconductor memories are available with very reasonable price which is easy to afford. So, with the development of micro-/nano-electronics, today's smart society with internet, artificial intelligence etc. does not exist, and thus, the invention of micro-/nano- electronics is the biggest technological revolution after that of electronics.

Speed: This is the one of advantage of Miniaturization which gives this process a special place in today's world. By Miniaturization there will be greater density and thus shorter paths. Due to small electronics, it enables higher frequencies and clock rates which makes it faster from old version and also make it smooth to run. Higher frequency makes its range in wide domain.

For example: SMT components to the necessity of designing customized hybrid and high-density components.

Less Power Consumption & High Efficiency: Miniaturised devices have nature of lower power consumption because of its small size. Power Consumption is proportional to load, capacitance and proportional to square of operational voltage. Since everything is really small the capacitance is also very small.

As an example, one could program a laptop to play a MP3. It would run the hard disk, the many GBs of RAM, and the big processor to play the MP3, same job could be done by much smaller circuits in a small MP3 player with great efficiency and less power consumption. A much larger circuit is used in laptop but same task can be done by smaller circuits.

Portability: Handheld devices or portable devices are becoming more popular as world transitions into place where people receive their data, news, information as it happens rather than after some time. Handheld or portable devices allow the owner to take their work or facility with them at any place. So, portability makes easy to acquire information or to do work or take

advantage of device at any place.

DISADVANTAGES:

It is just a basic rule in the world that nothing is perfect, definitely there are some disadvantages if one has many advantages. Pros and Cons are connected to each other.

Thermal Issue: In Miniaturization Thermal increase or over heating issue is major disadvantage of it. Decreasing feature size and increasing package densities are making thermal issue extremely important in integrated circuit designing. Even a recent study shows that a large proportion of field failures can be attributed to overheating [7]. High die temperature affects circuit behaviour in a number of adverse ways. For example: the mean time to the failure due to electro migration decreases exponentially with rise in temperature. To reduce the effect of thermal increase in devices Thermal Management is very necessary for miniaturized electronic devices.

Thermal Management: It is main challenge for present as well as for our future of electronics. New technologies have to need to extract the heat in more sustainable way. The important and effective method is use of microfluids. It produces monolithically integrated manifold microchannel cooling structures with great efficiency [8]. It has great potential for lowering the temperature of electronic devices. By bringing coolant directly contact to the chip makes it more efficient. Also, microfluidic cooling system is low-cost process which is closely aligned with electronic components.

APPLICATIONS:

The development of electronics is related to miniaturization. As seen from history, at first computers were room sized, as the time passed the computers became smaller and smaller in size with more advanced features, computing power and memory by several orders of magnitude. Miniaturization enables the use of electronics in more broad areas like space programs, researches, automobiles, households, mobile phones, wearable electronic devices, aerospace, military etc. Almost in every sector electronics is being used with its advanced and Miniaturized version which is making the world move towards future with high performance, great technology, small space devices. In recent time, Media professionals are using miniaturized electronic devices like pen camera and button camera and more such devices for some tasks. Also, like this Military and Medical sector have also increase demand of miniaturized devices for their efficient work. Medical device industry is

observing a great increase in demand of nano-sized robotic surgery equipment. Today, world is active to explore artificial intelligence and robotics, and miniaturized electronics is playing a major part in its development.

CONCLUSION:

Miniaturized electronics continue to evolve every day, its need and demand is increasing day by day. The miniaturized electronics includes an infinity of new application which will become a necessity in near future, but there is still a long way to do. Miniaturised electronics has long and innovative history and it still continue to rely on making history with its ingenious and advanced technology/ devices, such as, Dolfi, Futuristic Display, Snowl, Tiny light, Adaprox fingerbot, Laser Pecker and many more. The understanding, development, continual learning of advanced electronic devices will place it in the necessary edge in its prototypic business.

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