

# Capacitor Trends and Challenges

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## ABSTRACT

Passive components market and supply chain has been under turbulent conditions recently with some shortage and limited supply issues especially on MLCC and resistors components. The paper will discuss passive components as a significant sourcing risk factor with need for especially capacitor supply chain optimization. The second part of the paper will focus specifically on MLCC trends, issues, performance, opportunities and further miniaturization options.

## Electronic Industry Trends

We are currently living in a fascinating time of transition into the new digital age of human history. The move is enabled by a fast development of electronics and computer segment bringing completely new level of networking and services in all aspects of our lives – see Fig.1.

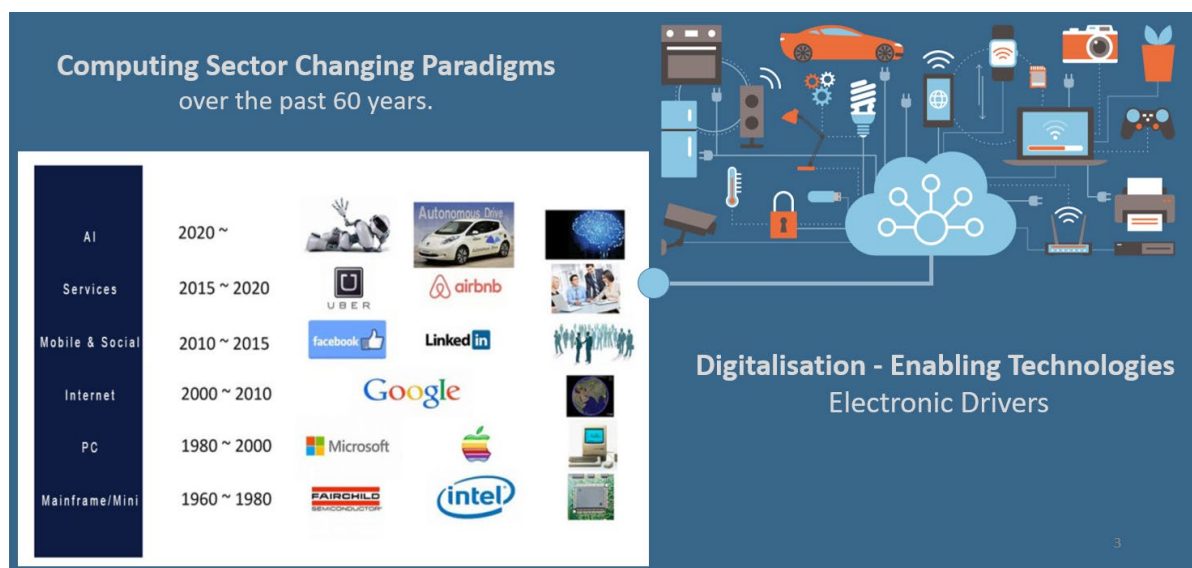


Fig.1. Computing sector paradigms changes and current digital services growth. Source: EPCI using Wikipedia and Depositphoto image

The new level of digital based services and networking are enabled by new electronic hardware, technologies with high computing, data transfer or storage capabilities. The recent platforms such as IoT, IIoT/ Industry 4.0, 5G V2X... are calling for exponential increase of global data traffic and mobile data that the electronic hardware and infrastructure must support.

### A. Major impacts to the electronic hardware requirements:

- wide increase of data to be processed on board
- move from RF to optical links (infrastructure)
- move from systems on PCB to system-on-chip
- higher density & integrated solutions
- digital, power, RF/optical signal interface to be managed within the same PCB/block, often with downsizing requirements.
- increase of dissipated power & operating temperature
- miniaturization – smaller and lower profile designs while maintaining/improving system performance
- cost & lead time reductions

## B. Consequences for board design architecture changes:

- a. move towards wide gap semiconductor technologies (GaN/SiC) for higher speed, higher frequencies and higher operating efficiency at smaller dimensions.
- b. possibility to expand higher temp applications because of high operating capability of GaN/SiC semiconductors
- c. due to the high number of different functions and interface types, more and more different supply voltages will have to be managed separately
- d. multiplication of Point-of-Load and Low-Drop-Out regulator
- e. increase of electromagnetic compatibility constraints - protect very small digital control and data signals in increasingly noisy electrical environments
- f. lower voltages and higher current DC-DC converters

## C. Consequences for passive components:

- g. low voltage, high capacitance, small size and low ESR decoupling capacitors (MLCC class II top of the interest)
- h. large capacitance, low voltage and low ESR bulk capacitors
- i. downsizing, embedding,
- j. thin film technology requirements
- k. 2D/3D printed components
- l. high current inductors
- m. overload protection by shunt resistors are mandatory
- n. EMI management
- o. introduction of 0402 RF inductors
- p. introduction of chip ferrite beads for power applications

references [1], [2], [3]

## TRENDS & OVERVIEW

The global passive component trend shows growing investments into development of new processes and materials to introduce completely new generation of passive devices. This includes also investments into manufacturing equipment and technological know-how.

MLCC SMD capacitor technology has been the leader in discrete passive components miniaturisation, where 0201 case size has become the major case size in 2018 and smaller case sizes down to 008004 are step by step adopted by consumer electronics production nowadays. The sub 0201 and high CV components (>1000 dielectric layers per chip) commercialisation was enabled by a technological generation upgrade from thick film to thin films.

### MLCC Market Situation

In 2018, we have seen dramatic increase of MLCC demand, followed by market disruptions and increase of price. Thanks to a recent softening in the global market, some relief in smaller case-size MLCC's can be seen. Most suppliers report bookings slow down, and some more common parts are becoming more readily available. Automotive grade MLCC's along with larger commercial grade components and high capacitance device continue to be either still on long lead time or controlled order entry. Legacy items continue to be constrained. European Market demand remains healthy particularly in Automotive and Industrial applications, where typically larger case size and high reliability are key. Automotive grade MLCC production continues to be fully booked until end of 2019 and according to many suppliers, automotive demand will continue to drive tight capacity for the next 2 years.

### Downsizing Trends

According to the Paumanok Research, the current ceramic capacitor market is 17.1 BB USD and it is still expected to grow significantly. In order to meet the future demand, production capacity is being redirected to smaller, more economical case sizes for those standard CVs. Various manufacturers reported that 0201 became the major MLCC case size in 2018 and it is expected to become mainstream in 2023 and end customers are being advised to downsize where possible to avoid future supply issues.

references [4]

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## SUMMARY AND CONCLUSIONS

Miniaturisation, high speed data communication, increase of computing power, energy generation, transmission and storage are the main drivers for next generation of electronics. These requirements may induce some dramatic market changes challenging the passive components development & selection guide. It may require some parameter improvements such as increase of operating temperature, vibration & harsh environment resistance, lower ESR, lower ESL etc that is achievable only by replacement of capacitor technology used at the application for decades.

Consumer market is the largest among the electronic applications with continuous growth, on the other hands, the “traditional” segments such as smartphones, digital cameras, PC computers, notebooks, tablets etc are beyond its mature stage with decline in sold pieces. The highest market dynamic is currently seen on automotive electronics and telecommunication/networking infrastructure, that are now on top of the radar screen of number of passive component manufacturers. Passive component makers are also more and more concentrating on development of a complete module solutions rather than development of individual components.

MLCC ceramic capacitor technology answers best the need for further miniaturisation and high-volume production capability to support smartphones and other handhelds. The MLCC market is expected to grow in various industry fields. Larger case size, higher power, higher reliability (e.g. Auto grade) or specialty MLCC products are still on long allocation or controlled order entry. Automotive grade MLCC production continues to be fully booked until end of 2019 and demand is expected to continue to drive tight capacity for the next 1-2 years. Hi-CV MLCCs supply chain is expected to have shortages to 2020 and beyond.

## REFERENCES

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- [3] Design Trends in Automotive Passives; Avnet Engineers Insight; <https://passive-components.eu/design-trends-in-automotive-passives/>
- [4] Paumanok Publications; MLCC Shortages FY 2019 - Tier-To-Tier Strategies and Alternative Reference Designs