# Challenges of Electronics Design in Automotive Application

An Interview with Mr Michael Mayerhofer, founder of Tekbox

with Dr. Min Zhang, the EMC Consultant, Mach One Design Ltd

**Background**

Many people in the EMC world know Tekbox for their cost-effective pre-compliance EMC testing equipment. Headquartered in Vietnam, this design company has managed to sell their products to every corner of the world. But few people know the history of the company, nor the fact that they are behind many electronics design of the LED lights used in many cars on road.

In this interview session, we interviewed Mr Michael Mayerhofer, the founder of the company. And the topic is around electronics design for automotive application. If you are new to the automotive industry, or you are also making high volume products (such as home appliance devices), then you should find the topics interesting and useful.

**Interview**

MZ: People are not familiar with the fact that Tekbox is also a design company, could you tell us what do you design?

MH: We design many electronics products for automotive application, you can find this information on our website. One of the things we are quite specialised in doing is automotive LED light circuits. So we design the hardware, i.e. electronics circuitry that you will find in many cars, such as JLR, Volvo, to name just a few.

MZ: For those people who are not familiar with the automotive supply chain, could you give a brief introduction of where Tekbox is in the industry?

MH: Car manufacturers often outsource parts to Tier-1 suppliers. The supplier companies that make car lights didn't have to worry about the electronics design until the LED lights become the standard parts for modern cars. The companies that make lights such as ZKW, Valeo, etc are often specialised in reflector, lens design, they don't usually have the resource for electronics design. For the sake of market efficiency, they outsource their electronics design to contract manufacturers, who are often based in Asia. Contract manufactures then outsource this to design companies, that's when we become part of the game.

MZ: That's kind of interesting, I was also involved in the EV industry for a couple of years before I started Mach One Design. You said designing this kind of electronic circuitry is not difficult, probably because you are specialised in it. For those engineers who are not familiar with the industry, could you give some examples of the challenges you are facing, particularly from the electronics perspective?

MH: Anyone who's involved in the automotive electronics design should design the circuit against manufacturer's specification. There are some basic requirements such

as nominal voltage (13.5V±0.2V), operating voltage of 7-16V, can withstand jump start voltage of 24V, cranking, etc.

But there are some other things that you need to take into account. For example, components such as MELF or Tantalum capacitors are not allowed simply because they are not considered as reliable parts for automotive applications.

There are environmental constraints, for example, the LED light circuitry should not be sensitive to moisture, so the creepage and clearance requirement should be fulfilled. The impedance of the design should be kept low, so there's no issue when things are getting wet.

MZ: What about capacitors?

MH: That's a good question. I just mentioned that Tantalum capacitors are not allowed, or at least not encouraged to be used. Most of the time, ceramic capacitors are not allowed to be connected between the supply line (KL31, KL30). If you have to, you need to use soft electrode type capacitors. This is because in case that a ceramic capacitor cracks, it is not producing a short circuit. Any capacitor that is larger than 1206 is not allowed. For PCBs that are easy to bend, the orientation of the capacitors needs to be placed so that when the PCB bends, the capacitors are least likely to bend/crack.

By the way, 4.7 µF is probably the maximum value that you can get, because any capacitance value larger than this one will be expensive. I think you covered this in your recent articles about capacitors.

MZ: Wow, that's super interesting. I remembered when I was working on a project in which the product is supplied to Mercedes Benz, I have seen two series connected ceramic capacitors placed in 90-degree orientation. At the time I was told it was for mechanical reasons. Now I see why.

Yes, I understand the exponential price increase when capacitance value increases and I talked about it in my recent article "Capacitors: Theory and Application"

How about the EMC design challenges?

MH: Obviously, you need to deal with the ESD, this is often done by transient devices. Then reverse voltage protection. Load dump is probably the most challenging one, because it is associated with a high energy and high voltage pulse that could destroy the whole circuit. The load dump protection is often done by a transient absorber.

A common mode choke (CMC) can often be seen in our design, but it is not favoured, simply because of the cost it is associated with. But in the end, without a CMC, the circuit will fail certain EMC standards. As the delivery date approaches, the purchasing team will often agree to have the CMC in.

MZ: That is a very good point. I would like to highlight this because this is actually the biggest challenge with volume manufacturing. To design something functional is

not the hardest part, to design something that is functional, passes all the standard, yet achieves the lowest BOM cost is perhaps the most challenging task. I still remember the days while I was working as a design engineer, I was given the task of designing a motor drive gate driver using transistors, resistors and diodes. There was a commercial driver which has the same form factor, great performance, and if you quote million a year, are just under one USD. But if you build discrete driver circuit, you probably end up saving a few cents. But that is the trick, if you can save 5 cents a unit, you save 50,000 USD a million.

So what's the development time in the whole product cycle?

MH: I would say, 10% design and development time, 40% test, and 50% review.

MZ: That's kind of crazy. But I think it is quite similar everywhere.

MH: Well, in automotive industry, safety and reliability are the first thing. So all these time spent in testing and review are necessary. And you cannot afford not to do so, because the penalty is very very expensive.