

EMC: Who's Job Is It Anyway?

Peter Hartnett.

Transparent Engineering Ltd. Venture House, Fifth Avenue, Letchworth, Herts, UK. peter.hartnett@treq.biz

Abstract: Who should take responsibility for achieving the best EMC performance for a vehicle? Suppliers are, as always, under pressure to meet increasingly difficult emissions and susceptibility targets. Can or should, the vehicle manufacturers do anything to help the suppliers? This paper discusses the correct balance between a macroscopic and microscopic approach to design responsibilities.

Introduction

Cost, reliability, space and weight are four main driving forces which influence the vehicle designer when deciding the wiring and grounding strategy. The choice of location for an electronic module will be loosely based on the electrical requirements but these will be subordinate to the main driving forces. The vehicle designer has to maintain a system overview which allows him to obtain the optimum compromise amongst all the competing requirements.

Vehicle manufacturers expect electronic module suppliers to take full responsibility for the EMC performance of their products. The consequence of this "hands off" approach is that the module designers, faced with a high risk of failure, will design-in preventative measures that might not be necessary. Cost optimisation is not achieved.

Of all the engineering challenges facing the vehicle manufacturers supply chain, the skills required to achieve acceptable EMC cross the most engineering disciplines.

When the competing technical requirements are examined, a "hands on" approach by the vehicle manufacture, throughout the supply chain, may be a cost effective response to the EMC challenge.

Standard EMC Considerations for the Electronics Module

Housing

Generally speaking, for high volume production, a plastic housing will be the lower cost option if thermal and mechanical requirements allow it. However, the perceived EMC advantages of a metallic housing will often lead to plastic being dismissed at an early stage.

A metal housing will provide screening but in the bulk of applications, the product susceptibility and radiated emissions will be determined by, and measured from the attached wires. In reality, the main electrical advantage of a metallic housing is likely to be the opportunity to use it as an EMC ground.

After making a decision to use a metallic housing, the designer is confronted with numerous difficulties concerning the grounding. Usually, an EMC ground connection to the PCB is required, also, a reliable ground connection at the housings mountings.

The ground connection to the PCB is mechanically challenging. Generally, the PCB will have some freedom movement relative to the housing. Any rigid connection such as a solder joint will fatigue and fail during the product life. The number of patents in this area is indicative of the difficulty of the problem and the demand for solutions.

It is at this interface that the vehicle designer and the module designer often come into confrontation. The vehicle designer may not want to guarantee a quality ground connection at the mounting point for the life of the vehicle.

Some vehicle manufactures provide an additional EMC ground cable to a local grounding stud on the car body. The efficacy of this connection is questionable if it is more than a few centimetres long. This situation will also not have been tested for; hence the EMC of this installation is unknown.

In short, the module designer is likely to choose a metallic housing and spend considerable design time in ensuring a good connection to the PCB and vehicle body.

Figure 1 Metallic housing automotive module



Photos courtesy of Trafficmaster

Figure 2 Same module, with plastic housing and acceptable EMC performance



PCB

The complexity and therefore the cost of the substrate should be determined by the circuit requirements. However, the uncertainty of the EMC behaviour during the design phase, will often lead to an early commitment to a more complex substrate than may be necessary. A circuit whose connectivity can be accommodated on a two layer board will often be assembled on a four layer board. The extra layers being justified by the as yet unknown EMC behaviour. The substrate is such an integral part of the product design that returning to two layers at a later stage after EMC behaviour has been analysed is rarely an option.

Most designers will allow space on the PCB for an EMC/ESD capacitor for every connector pin. This extra space will increase the cost of the board. The requirement to place the components near to the connector pins leads to congestion around the connector and non-optimal tracking.

If an EMC connection to the housing of the module is required, this is likely to require considerable space and may be associated with patent licensing requirements.

In summary, the PCB is likely to be larger, contain more layers, cost more, and have a none-optimal routing because of EMC fears.

Components

Passive Components

EMC/ESD capacitors on the connector pins are very common in automotive electronic modules. Each capacitor provides a supposedly low impedance path to a supposedly good EMC ground which is usually part of one of the extra layers.

In reality, chip capacitors together with associated parasitic effects, form a filter that is only highly effective at quite narrow frequencies. Additionally, ceramic capacitors are readily destroyed by an ESD event of the magnitude which most vehicle manufactures require. Such low capacitor values are also notoriously difficult to test in situ.

It is common practise to place such a capacitor on every pin. The resulting congestion has already been discussed. The cost of the capacitors themselves although small is non-trivial particularly when the assembly time is considered.

Figure 3 Connector Area EMC/ESD Capacitors

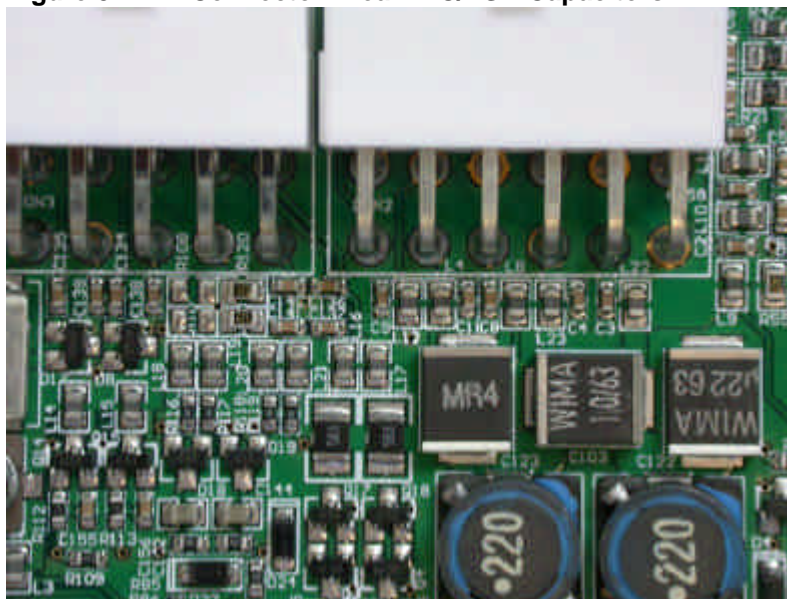


Photo courtesy of Trafficmaster

Active Components

Most active components are capable of generating the fast edges associated with radiated emissions problems, from the snap off effect in a diode through to the complex switching of a micro-controller. The maxim must always be, “not as fast as possible, only as fast as necessary”.

Micro-controller manufacturers will “push” their new products and withdraw support for old ones. Direct marketing to vehicle manufacturers will often lead to the module supplier being told which micro-controller to use. The EMC consequences can be significant but not visible to the vehicle manufacturer. Also, micro controller suppliers may switch to smaller geometries for yield reasons, giving faster devices. However, what is good for the supplier may not be good for the EMC performance.

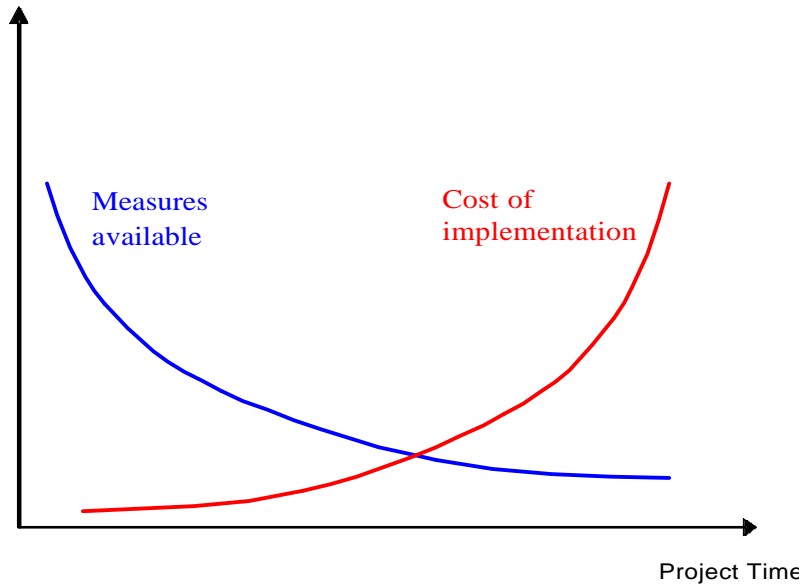
Conclusions

By getting more involved in the module design, the vehicle manufacture may be able to share in cost reductions gained by a judicious choice of EMC measures.

Additional costs due to EMC	Vehicle Manufactures Input
Multi-layer pcb	Support first iteration on minimum number of layers. Share risk and benefits
EMC/ESD capacitors	Joint assessment of ESD exposure in vehicle. Do all pins need extra protection?
Integrated circuits	As fast as necessary not as fast as possible. Involve module designers in the choice of uC.
Metal housing	If the thermal and mechanical requirements do not force the use of a metal housing, work with the supplier and share the risk/cost benefits of a plastic housing.
Contacts to housing	Provide a good high frequency connection to the body of the car at the mounting points.
Development time	Accept that the development process requires design iterations. Allow an EMC design iteration.

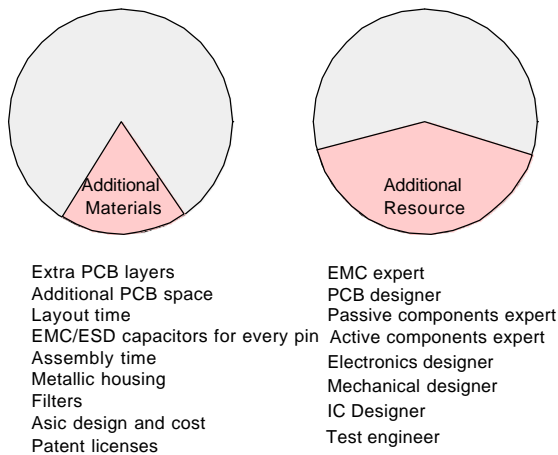
The well known curve shown in figure 4, has led to many designers implementing every conceivable EMC measure into their modules at an early stage. The resulting cost is carried for the life of the module but the actual benefits may not be clearly understood.

Figure 4: EMC Measures vs Cost



How much of the module cost pie is due to EMC measures (Figure 5)? There is no easy answer but it is a significant sum. By sharing risk in the development phase, the vehicle manufacture should also be able to share in the savings that could be achieved by only implementing those measures that are genuinely necessary.

Figure 5: Electronic Module Cost Pie



EMC – whose job is it? Everyone involved in the vehicle.

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About the author:

Peter Hartnett is a graduate of Liverpool University (Electronics). He is a chartered electrical engineer (CEng), member of the IEE (MIEE) and SAE. He has worked for the Ministry of Defence, Robert Bosch GmbH in Germany and the Motorola automotive division. His involvement in EMC has included work at the component, module and system level.

Owner and MD of Transparent Engineering Ltd.