

Training and Certifying Engineers & Technicians for Automotive EMC

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Abstract— The training and certification of EMC personnel to work in the automotive industry requires a unique and remarkably broad range of education, experience and talents. The growth path for someone looking to make this avenue a career choice will likely take them into many areas where they originally had not planned to go. Along the way, expect to roll up your sleeves, and get your hands dirty.

The Automobile and Electronics

The contemporary automobile can be seen from a great number of points of view. Some declare it a work of art. Others a mechanical marvel. A few see it as the major contributor to our atmospheric pollution. Most see it as a convenient and economical means of local transportation. I dare say that all of these views are correct and that only the emphasis changes.

The EMC engineer, on the other hand, is likely to look on the automobile as a mobile platform carrying a suite of electronics that rivals a modern jet aircraft in its complexity. Sensors and actuators abound in the cab, under the hood, in the trunk, imbedded in the tires. Indeed, even the operation of the engine is governed by computer control and the doors are unlocked by an RF link.

All of these devices are required to interact in a vehicle that can be virtually anywhere on the surface of planet earth, exposed to a bewildering variety of intense RF environments.

We literally drive our cars everywhere, and think nothing of parking next to a TV or radio transmitting station, or at an airport within the sweep pattern of the radar, or if you work at the airport, under the nose of an aircraft, with all of its radars and communications antennas just a few feet above your vehicle. dare say that all of these views are correct and that only the emphasis changes.

For those of us aware of the potential for EMC problems, this scenario of driving a platform of electronics within close range of strong RF sources is daunting, to say the least.

Electronics and EMI

Naturally all that potential for interference coupled with all of the electronics on one platform makes automotive manufacturers nervous, and with good reason. The unintended deployment of an air bag system, accidental operation of a wiper system or the failure of an anti lock break module could have catastrophic results for the vehicle, the driver and the passengers.

Make no mistake, safety is always the prime concern, as it should be. As a result, all of the automotive manufacturers and their suppliers place great importance on ensuring that the integrated platform (The car and all of its electronics.) meet stringent EMC requirements for each individual electronics package, system and the entire vehicle.

Each electronics package is subjected to intense scrutiny for unintended electronic emissions, and immunity, in both conducted and radiated forms. When all have passed the required tests, total system integration is performed by the OEM, and then the entire vehicle is tested again for any unwanted performance deviations. If the vehicle does not pass, it cannot be sold!

EMI and the Engineer

The engineering talents necessary to design, test, and finally successfully integrate all these elements into a compliant platform receive the conventional electronics education. So what else contributes to turning an automotive electrical engineer into an automotive EMC engineer?

Vehicle Experience

While not an absolute requirement, we find that most automotive engineers and technicians are car enthusiasts. If they are not designing components for full vehicles, they are driving cars; working on cars, polishing cars, playing with cars...you get the idea.

I won't say that "Must love Cars" is a necessary requirement to be an automotive EMC engineer or technician. But, an understanding and appreciation of total vehicle design and

performance is a good start to understanding how the system will integrate all of its diverse elements into a successful package.

Beyond the EE degree

A young engineer with a BSEE degree has the assurance of his college or university that he is ready to enter the 'real world' and design electrical and/or electronic products. What a shock it is when his first design fails the required EMC tests!

At this point, most engineers dealing with modern systems discover some of the well taught classes and workshops provided by experts in the field that fill the gap left by our institutions of 'higher education'. This is often the first step in the real education of an EMC engineer.

For the Automotive EMC engineer, there are a few more 'shocks' to be absorbed.

EMC Standards

Sad to say, but often the first mention of the term 'Standards' is not while the student is in school, but only after he enters the work force. Indeed, the whole concept of a 'standard' is again usually encountered when our young engineer discovers that his new prototype must pass an entire battery of 'standard' tests before it will ever see the light of day outside of his company.

For the Automotive EMC Engineer, the list includes; International National and a number of OEM Standards: (Example: For the US)

- IEC/CISPR/D
- ISO TC77
- ISO....
- SAE J551 & J1113
- Chrysler
- Ford
- GM
- Honda
- Toyota

Similar sets of standards apply to EMC engineering in any particular EMC sub-discipline.

EMC Cooperation

Among the normally fierce competitors, the US 'Big 3' (Chrysler, Ford & GM) EMC teams have established a unique and remarkably effective cooperative EMC alliance. The Automotive EMC Laboratory Recognition Committee (AEMCLRP) works toward alignment of the individual company EMC specifications toward common, recognized international standards and the establishment of a common program for laboratory accreditation.

The Automotive EMC Laboratory Accreditation Plan (AEMCLAP) is administered by the A2LA (4) in the US, by other organizations in the EC, Japan and SE Asia. This 'Plan' applies a common set of criteria for the accreditation of automotive EMC laboratories uniformly across the industry to ensure balanced and coherent application of the standards, world wide.

This methodology for aligning the test practices in each automotive EMC laboratory ensures that the practical application of the test standards achieves the required level of uniformity. The intent is to ensure that a test conducted in each of the automotive EMC laboratories corresponds closely to that of the rest of the industry. From the point of view of an OEM charged with the systems integration of the entire vehicle platform, this assurance of uniformity among all of its suppliers is critical.

EMC Test Training

Training engineers and technicians to conduct specific EMC standard tests requires a strong familiarity with several aspects of the test:

- The relevant national, international or company standard.
- The detailed test procedure developed by the EMC laboratory,
- The function and operation of the physical equipment and
- Hands-on operation of any control and monitoring software.

To fulfill the training requirements represented by this list requires that the test organization develop a systematic method to introduce new test engineers to the materials. At EMC'04/Sendi I introduced a methodology for establishing and documenting such training. (1) We have been using this method continuously at our EMC Laboratory and have been very pleased with the results.

EMC Society

Of all the technical organizations that support the development and extended education of EMC engineers, the leader in all aspects is the IEEE Electromagnetic Compatibility Society. Through its yearly EMC Symposium, its Transactions, its Newsletter and its world wide network of local Chapters, the EMC Society fosters an astonishing degree of activity focused on the needs of practicing EMC engineers.

The EMC Chapter located in Southeastern Michigan is the organization with perhaps the most focus on automotive EMC. This Chapter sponsors free, monthly meeting/lectures by local or internationally known EMC experts. It also sponsors a yearly 'EMCFest' as a one day 'mini-Symposium' with a high profile speaker and many EMC related exhibits.

In addition, the Chapter conducts a biennial (every other year) 2 day workshop on automotive EMC standards that attracts attendees from all over the planet to hear what the automotive experts in Motor City have to say about automotive EMC testing, standards and where they believe the industry is going.

Future plans for this chapter involve the development of a series of 'Best Practices' automotive EMC workshops. These will provide a venue for the mutual exchange of practical EMC test and engineering methods developed independently by each of the participating test lab or engineering group.

EMC Personnel Certification

As the engineer or technician experience grows, he has the possibility for attaining international certification in the field of EMC through the interNational Association of Radio and Telecommunications Engineers (iNARTE) (3).

The iNARTE certification involves a review and confirmation of the applicant's educational status, a review, with references, of his past employment in the field of EMC, the submission of a set of 10 questions in his area of expertise to be considered for inclusion in the iNARTE question 'pool' and a two part, 8 hour examination. The first part of the examination covers fundamental EMC theory, while the second part deals with the practice of EMC engineering or technician aspects of the profession.

This certification is 'portable' in that it is not tied to the individual employment, and can move with him as his career takes him to other employment opportunities.

EMC and Future Automotive Technologies

Several of the evolving technological inclusions in the near future have strong implications for the future of automotive EMC engineers. Wireless based sensor communications, Hybrid drive & 'fly-by-wire' steering and break systems all speak to the need for a strong assurance of platform EMC integrity and security.

If we are to take full advantage of the promise each new innovation provides, we must also address the growing need to improve the level of total systems integration assurance, not only at the final OEM assembly but, also at the individual component supplier.

The practical difficulties in conducting full systems integration testing by the OEM after all component development is complete are daunting enough.

Even for the OEM's EMC test labs, getting their hands on the next model year vehicle for total systems testing is nearly impossible. The demands for access to that same prototype

for all the other systems tests, road testing and sales and marketing make it a very 'hot' commodity.

EMC Platform Modeling

The financial implication of asking all the automotive suppliers to establish complete vehicle test capabilities boggles the mind. At this point, the most promising option is total EMC systems level modeling.

Years before the final hardware that we know as a motor car is available, the CAD designs for the total body, wiring harness layout and major module locations are all available from the designers.

EMC modeling software has proven itself successful at the component and sub system level in automotive applications. The computing power needed to handle the number of constraints necessary to successfully model the entire platform is now available in affordable, conventional desk top machines. Total system models for military and aerospace applications have proven themselves to be successful at the 'macro' level.

What we need now is the experience of trial and error to begin to refine the methods of bringing all this information together in viable models to allow EMC engineers to predict total automotive systems behavior, once individual module characteristics are known.

One might reasonably ask, "Why at the supplier? Isn't this the job of the OEM's?" The answer is, of course, yes and no. If we wait until the OEM begins systems integration to evaluate how the module will 'play' with the other systems in the platform, it is probably too late to address a module level problem and solve it before the vehicle 'launch' date.

Unless we develop methods of evaluating total system performance early in the entire program, we will always be in the position of chasing last minute problems due to system level incompatibilities.

EMC Related Systems

The list of systems that are now or will soon be powered or controlled by electronics in the modern automobile is daunting. Adaptive Suspension, Cooling Fan, AC Compressor, Heated Windshield, Water Pump, Central Locking, Power Windows, Seat Adjust & Heating, Climate Control, HI-FI Amplifier, Rear Defogger, LED Lighting, Electro Hydraulic Braking, Fly-by-Wire Steering, Central Tire Pressure Monitor & Control, Heated Side Mirrors, Vision Systems, Heads Up Displays, Collision Avoidance Radar Systems, etc..

In Kyoto in 2002, Claus Geisler addressed the MIT 42 Volt Consortium and outlined the power requirements for current

and new innovations in automotive technology. The list of these is shown below: (2)

ZONE LOAD	WATTS
Engine Adaptive Suspension	300
Cooling Fan	550
EHB	700
AC Compressor	600
Heated Windshield	550
Water Pump	300
EPS	800
Catalyst	800
Cockpit Central Locking	215
Power Windows	190
PTC Climate	400
Seat Adjust & Heating	200
Rear Central Locking	215
Power Windows	190
Rear Seats	200
Hi-Fi Amplifier	240
Rear Defogger	300
LED Lighting	<u>50</u>
Total Vehicle Power	6800

If we believe the guidance of our technical leaders in EMC and 'follow the current', a simple division of 12 Volts into the Wattage numbers in the table above suggests that we are and intend to expand, the control, and switching of large currents around the vehicle. Each current and each transition gives rise to EMC concerns.

It will be the job of automotive EMC engineers worldwide to assist their company internal design teams to address these concerns and provide vehicle components that meet both the 'form, fit and function' requirements of new systems, but also integrate smoothly into the total platform.

Beyond its technical content EMC engineering demonstrates strong alignment with socially responsible behavior. Completely aside from its technical benefit for more efficient operation of devices and systems, the entire rationale for the existence of EMC is the protection of others from the side effects of electronic operations.

This is socially responsible behavior at its highest, where there is no inherent gain or benefit to the individual performing the act, but only benefit for the community as a whole.

Personal Satisfaction

Finally, I must take a moment to relate the long term experience that EMC as a career choice has provided me. Over the past 27 years since I made my final move from conventional electrical engineering control systems hardware and software design, EMC has kept my interest occupied my enthusiasm up and my commitment to a job worth doing, and worth doing to the best of my ability, at a consistently high level.

No job is without its 'down side'. But, EMC engineering has, for me, had very few, and many more 'up side' experiences to compensate. I encourage any young engineer to seriously consider it as a career path.

Even more important; the quality and integrity of the people that it has been my privilege to work with in EMC engineering has proved to be of the highest caliber, and most noble character. All that I have known well, I am proud to call my friends, as well as my colleagues. I wish you all the same life experience as you move forward with careers of your own.

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REFERENCES

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2. Geisler, Claus, "Does the Semiconductor Industry Drive Automotive Innovations?" Keynote Address: 2002 MIT 42Volt Consortium Meeting, Kyoto, Japan.
3. iNARTE, iNternational Association of Radio and Telecommunications Engineers, www.inarte.org,
4. A2LA, American Association for Laboratory Accreditation, www.a2la.com, (Search AEMCLAP).

Social Implications