Design guideline for plastic parts that need to fulfil EN62368 norm

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Abstract. The EN62368 norm is a European standard that specifies the safety requirements and the testing procedures that all audio/video, information and communication technology equipment need to fulfil. In order to fulfil this standard, all mechanical engineers should change the way of designing the parts and respect new rules that can increase the cost of production for all plastic parts. These changes will lead to a higher tool complexity and high material costs. Plastic material suppliers are starting to change their focus and develop new V0 materials with better and eco-friendly properties according to the market needs. Plastic materials with flame retardant compounds (FR/V0 – classification according UL94) need to pass all flammability requirements and tests and according to environment regulations, the plastic materials that are halogen free are more are more requested. In general, halogen free systems produce less smoke and less toxic components in smoke. Benefits of halogen free V0 materials is a better flame-retardant property, low smoke toxicity, low smoke obscurity and no corrosive gases. The tool complexity will increase because we must reduce, even avoid, the openings in all plastic parts because they will allow oxygen to get inside the ECUs and oxygen is maintaining the flame, making a potential ignition source to increase her breadth. Reducing the openings in a plastic part, will lead to adding sliders inside of the mould and sliders involves higher costs. Although, depending on the current that goes through the ECU, we can recommend you some design modifications that will save money and time for your project.

1. Introduction
Safety of your life and of your goods matters. Fire is one of a multitude of factors that can affect your safety. In automotive industry, the V0 materials can solve this issue that affect a part of all electronic components. EN62368 standard is a European norm for audio/video, information and communication technology equipment. In this standard is specified what products are affected and what are the material requirements and tests that you need to pass. Before EN62368 the standard that was mandatory to fulfil was EN60950. The new norm compared with the older one is applicable to a bigger variety of products and technologies. Was a need for this new norm because the technology is in a continuous changing and EN62368 is technology independent.

2. Affected products according to EN62368
Nowadays, all products (audio/video, information and communication technology equipment) shall comply with safety requirements. Availability of the safety requirements and implementation of the requirements become major quality challenge from design and cost impact points of view. Simply
faults are not only related to the efficiency of processes, but also represent a threat to people, their environment and their properties.

All products including the products which are in current development and need CE symbol are affected by this standard. This norm is applying also to countries which are not in Europe but need CE symbol on their products.

3. Product classification
The power source (PS) is the main criteria for classification:

- PS1 power source smaller than 15W.
- PS2 power source between 15W and 100W.
- PS3 power source above 100W.

This power source is not thermal generated power. Is the power that comes from the product. PS1 products cannot start a fire because of the low power that goes through the product and this means that are not forced to use flame retardant materials in order to fulfil this standard.

PS2 products need to have minimum a V1 material for the printed circuit board (PCB). V1 is a weaker plastic material than V0 according to UL94 (the Standard of Flammability of Plastic Materials for Parts in Devices and Appliances testing). V letter is referring to vertical burning and 1 means that the burning stops within 30 seconds on a vertical specimen and are allowed drips of particles as long as they are not inflamed. If the PCB is made from V1 material and after the single fault test can be found a resistive potential ignition source (PIS), is mandatory to use V0 material for the plastic housings.

For PS3 products is mandatory to use V0 materials and to separate the PIS that will appear after the single fault test from all combustible materials.

4. Test procedures
Single Fault Test (SFT) is an electrical safety test and its procedure consists in a simulation of a normal use of the product with variations of the current till a hazard or an abnormal failure is occurring. Such conditions can be an interruption of the protective earth conductor, an interruption of one supply conductor, the appearance of an external voltage on an applied part, the failure of basic insulation or a failure of temperature limiting devices.

With this test can be detected an arching/resistive PIS (the location where a component may ignite due to excessive power dissipation) and to minimize PIS occurrence in a product.

Figure 1. Illustrations of RESISTIVE PIS (components which are dissipating more than 15W).

Figure 2. Illustrations of ARCING PIS (broken connections or opening of contacts).
According to EN62368, there is a dangerous area around a potential ignition source that is clearly specified in the norm. Around a resistive PIS is considered a keep out of 5 mm and for an arcing PIS a keep out of 13 mm around the possible starting point of the flame and also a height of 50 mm that will form a cone similar with the orange ones illustrated in Figure 3. This need to be taken into account and to close the openings that will intersect with those cones in a way that the plastic part will create a barrier for the flame and in this way will stop the spreading of the fire inside the ECU and implicit inside the car or at least will give time to the driver to stop the car and to get out before a disaster will happen.

There is a test procedure that is called Needle Flame Test (NFT) that consist in keeping a plastic part (housing) exposed to a direct flame for 60 seconds. The test is passed (respects EN62368 norm) if after 60 seconds cannot be saw a hole made in that part and also the part didn’t burn with flame. The plastic part can melt but without creating a hole the in exposed surface and without creating plastic drips that can fall on other surfaces. On Figure 4 you can see a needle flame test performed on plastic probes, but this test can be performed also on plastic parts (housings) in order to find if a product needs V0 material or is enough a lower flammability class material for the product.

Flammability class of a material it is mentioned in the yellow card (UL 94). In yellow card there are information about the design of the product (e.g. the same material for a wall thickness of 1.4 mm is reaching V0 flammability class, for a 0.75 mm thickness is only HB). Bellow you can find an example of material classification considering the thickness of the material. You can find this information also in the material data sheet of the resin that you work with.
Table 1. Example of an extract from a material data sheet regarding flammability properties.

| Flame rating | Value | Test Method |
|--------------|-------|-------------|
| 0,75 mm; ALL | HB    | UL 94       |
| 1,2 mm; ALL  | V-1   | UL 94       |
| 1,5 mm; ALL  | V-0   | UL 94       |

5. Flammability definition
For our products, flammability represents a big danger for human life. We all know that thermoplastic materials can burn regardless of the material flammability class. To start a fire, we need three elements: heat source, material and air (oxygen). Removing any of those elements we will prevent or extinguish a fire.

According to EN62368 is mandatory to use plastic materials with flame retardant compounds for the aware products and to not exceed opening in our housings of 5x1mm cumulated on the complete assembly. In this way we will prevent air flow inside the product.

6. Plastic material with different flammability behavior
A V0 material is not a material that don’t burn. Is a plastic material that resist a small amount of time under direct flame without burning or creating a hole. In all material data sheets for plastic materials, is specified the thickness of the material where flammability properties are better. Even if we buy a V0 plastic resin, if our part will have a smaller thickness than the one specified in the material data sheet, we will result in a part that does not complain with the EN62368 norm, explicit we will have a HB (horizontal burning) material or a V1 material.

Another restriction that need to be considered when choosing a plastic material is to take a material that is halogen free. Benefit of halogen free is less toxicity, common steel for the screw of the injection machine and tool cavities and no corrosive gases. Halogens are a group of six chemical elements: Fluorine, Bromine, Chlorine, Iodine, Astatine and Ununseptium. Last three chemicals are insignificant for technical applications, but Fluorine, Bromine and Chlorine are relevant for electromechanical products. Especially in the case of fire, Bromine and Chlorine may form corrosive and/or toxic compounds. For this reason, the demand for halogen-free technology is increasing. Products are declared halogen-free if they respect the following limits: 5 ppm Chlorine (Cl), 5 ppm Bromine (Br) and 10 ppm total halogens.

7. Design recommendations
The main influence factors to be consider for proper design concept for safety are material properties, air flow rate in the surrounding of the ECU, electrical and mechanical components placement in regards with the source of fire occurrence and spreading, design measure to control the spreading of fire after ignition.

How to handle openings in a plastic housing?
Perform SFT around the openings in order to determine if you have an PIS around it. In Figure 5 is an example of a connector opening where we considered a PIS between the copper traces (marked with orange lines in the picture) that are visible right below the opening.

For an opening bigger than 1 mm x 5 mm is recommended to use one of the following two solutions. Even if this will involve higher cost for the tool production, is important for flammability issues to avoid air flow inside the ECUs.

First solution will be to close the gaps even if this will add a slider in your molding tool for the plastic part. See Figure 6 for detailed explanations.
Figure 5. Openings in a connector (made to avoid slider in the tool).

Figure 6. Solution 1. Closing the openings.

The second solution is to add a rib around the opening (similar with the yellow rib from Figure 7) that will have stop at 0.3-0.5 mm above the printed circuit board (green part). This rib will create a barrier against fire around the hole and will isolate it. This solution will save the costs of adding a slider in the plastic molding tool.

Another solution for the products that are in development would be to choose from the beginning a V0 material for their design and to create the geometry and the tool for molding respecting the design draft angles and material thicknesses for a flame retardant material but to used for the first samples a HB material that have a similar shrinkage coefficient like the V0 material. If the samples will pass one of the NFT or SFT procedures that the design can continue with the HB material as defined solution. If both tests will fail is clear that is needed a V0 material for that product. In this way can be saved a lot of money in the development phase, avoiding a change of tool or design in a preliminary phase.
8. Conclusions
All mechanical engineers that are developing audio/video, information and communication technology equipment, need to know the restrictions that EN62368 standard bring new to the safety requirements and regulations that they had to respect till now and to design their products considering this safety measures that will help them to save costs, time and resources for their project. Design well, choose the proper material for your product and collect the success.

9. References
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Figure 1, 2 and 4 are crops from google pictures and YouTube videos.