Green Design in Electronics

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Abstract

Green Electronics is currently one of the most important topics in the Communication, Computing and Consumer Industry. Besides a focus on energy reduction, Original Equipment Manufacturers (OEMs) within the Electronics industry are banning the use of certain halogens as a flame retardant substance in plastics. The whole Electronics industry is currently active to switch to plastics with halogen free flame retardant substances. However, in certain areas OEMs and connector manufacturers may face a significant impact on mechanical and flow performance as well as on the total system cost. For certain very high temperature plastics which are typically used in connectors and sockets, quick solutions on short term is therefore hardly possible and often require a full re-qualification of connectors including major changes in the tooling. In this paper we discuss various options for Green Design which allow the use of halogen free plastics without jeopardizing on product performance, safety, and cost and without re-qualifying the connector or retooling the system. The paper is in direct alignment with a new IEC62368 standard, which globally leading OEMs have started adopting based on the content of this Green Design approach making their products halogen free.

Introduction

Original Equipment Manufacturers (OEM) and Connector manufacturers for many years have been specifying plastic materials, to conform to meet the UL94-V0 flammability standard for plastics, for connectors and sockets. This generic specification enabled the use of identical connectors and sockets in any application and no further differentiation needed to be accounted for. It also gave the connector designer a higher safety margin on his design. This was an easy approach to implement, however it introduced over specification for many of these applications.

To make some plastics flame retardant, certain halogenated compounds (a subset of which are brominated flame retardants, or BFRs) are commonly used. Polyvinyl Chloride (PVC) is used for many cables and wires with chlorine acting as an efficient flame retardant.

BFRs and PVC are non critical in daily use by the end customer and show very effective flame retardant (FR) activity. They also have good performance-safety balance. However, the inappropriate incineration (<800°C) in the end of life cycle of electronics equipments has led to a growing concern that these materials may have risks to health and the environment. As a result, a number of OEMs as a part of their environment initiatives are setting deadlines to ban the use of plastics containing halogens.

The move to halogen free plastics is not easy. In significance it is similar to the move earlier, by the electronics industry to go lead free, but with much shorter implementation time. This brings challenges in supply chain and secondly, the reliability of halogen free flame retardants is not tested on a long term. Further, a halogen free high temperature plastic cannot be a drop in replacement for the existing plastic with halogenated flame retardant. These need to be clearly thought of, together with the mechanical properties, flow, and cost compromises to meet the design and environmental needs.

Plastics suppliers including DSM are active to address the situation. We at DSM are equipped well, with our track record of over 15 years in the use of halogen free polyamides in this industry. Further with our experience and also our direct involvement and membership at the International

Electrotechnical Commission (IEC), we understand the recommendations of the new IEC standard for this industry, the IEC62368. This new standard lays down design considerations of new electronics to enable them to be environmentally safe. This is also known as **Green Design.** This is a viable path towards a fast and cost effective move towards **Green Electronics** which are safe and pose no threat to the environment. Since connectors and sockets are the biggest areas of concern, this paper will primarily focus on Green Design of these components.

IEC 62368 standard

Currently IT and Audio/Video equipments follow two different IEC standards, IEC 60950-1 and IEC 60065. The IEC 62368 harmonizes these two standards covering both IT and audio/video applications. OEMs will have 5 years from Jan 2009 to adopt the new standard.

This IEC standard differentiates between various applications and this presents an easier and a quicker workable solution for designers. With this move to the new standard, the IEC is now also covering the probability of an existing, external flame caused e.g. by a candle which can accidentally ignite an electronic application when in close proximity.

Figure 1 shows the overview of the new IEC standard.

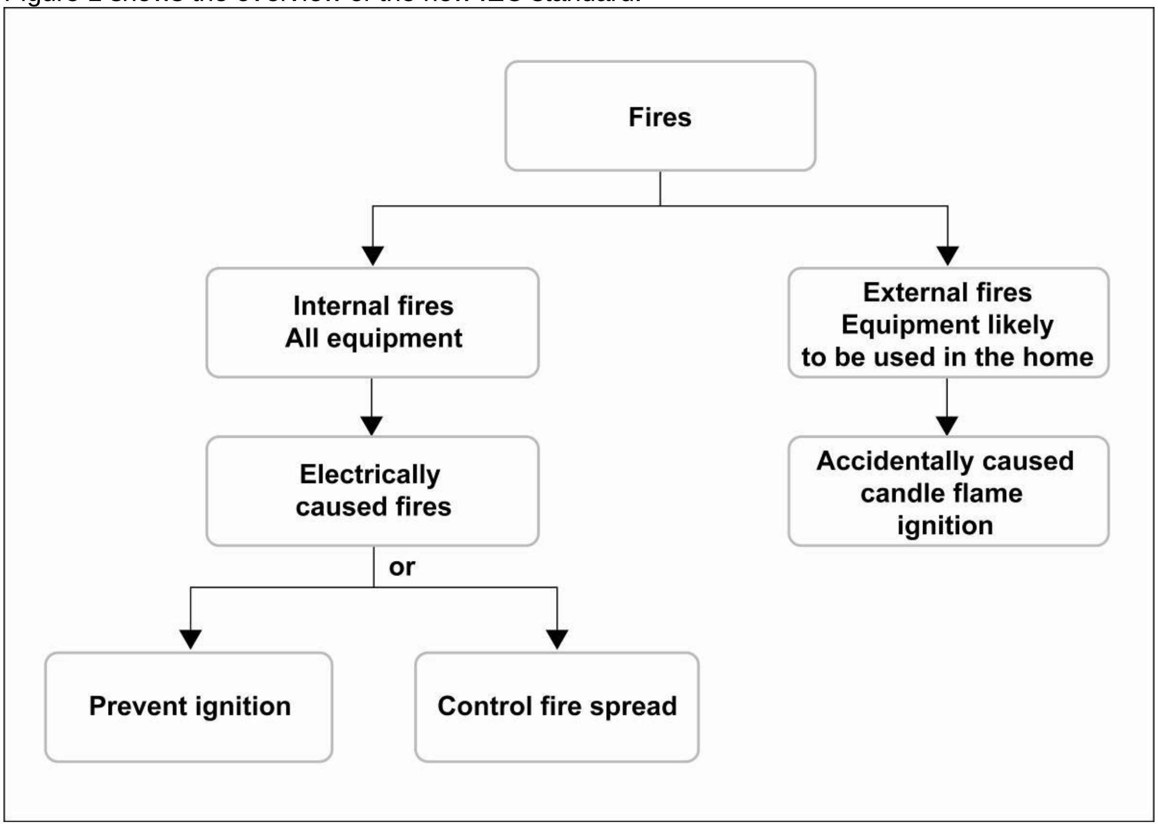

Figure 1: IEC62368 specification deals with fires in electrical applications. Internal as well as external fires are covered.

A fire can have two sources: either it is caused internally within an electrical equipment by e.g. malfunctioning components or it can be caused externally e.g. by a candle accidentally getting too close or in direct touch with electrical equipment. In case of an internal fire, a designer has two options to take precautionary methods: he can either design the equipment to prevent ignition, or he can design the equipment to avoid the spread of fire.

To summarize the IEC62368 standard, we have differentiated between internal and external connectors and also included some examples to enables a fast transfer to the applications.

Internal connectors
Ignition as well as spread of an internal fire depends primarily on the power level of the electrical circuit. As shown in figure 2, depending on the power level there can be three categories, PS1, PS2, and PS3.

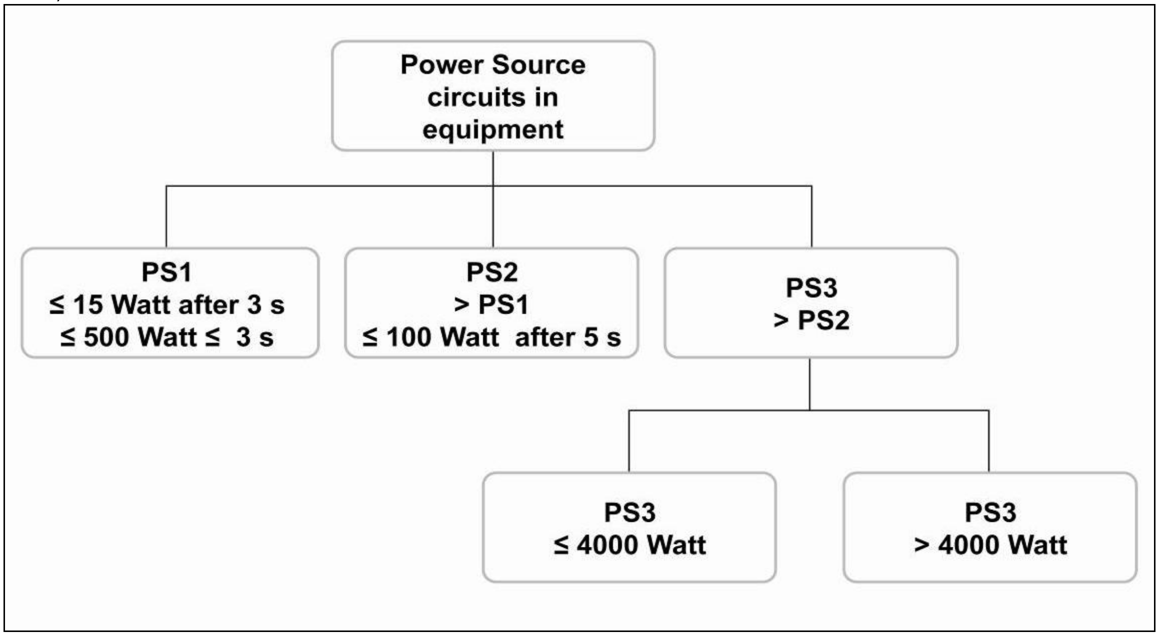

Figure 2: IEC62368 classifies three different power sources PS1, PS2 and PS3.

Figure 3 shows the impact of the power source on ignition.

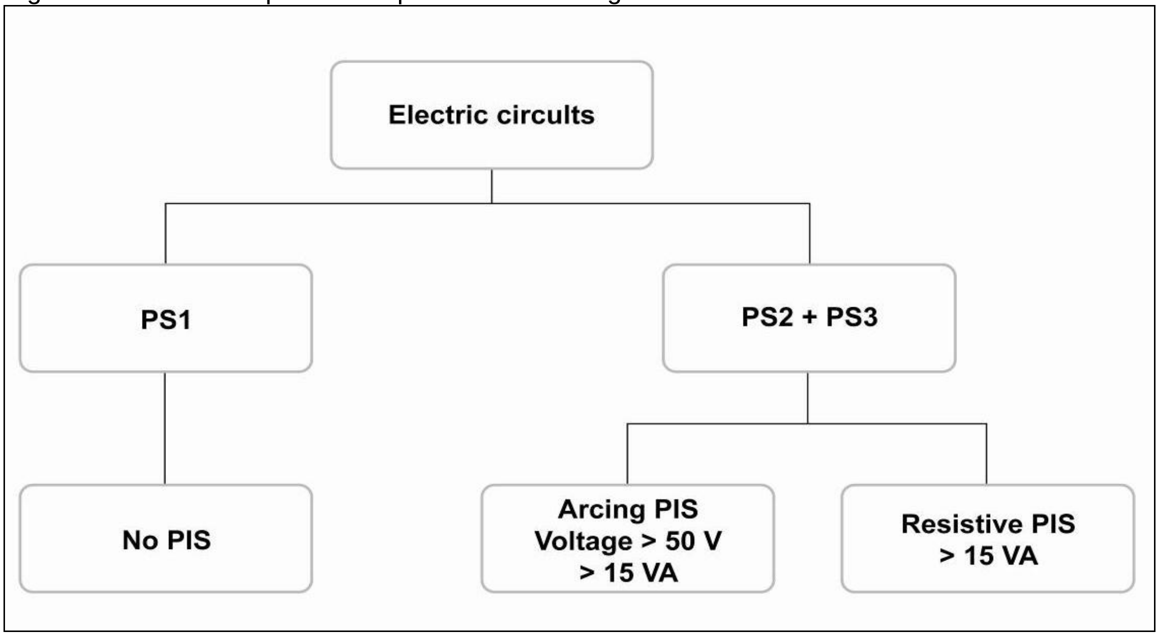

Figure 3: Impact of the power source on ignition.

A PS1 is a non potential ignition source (PIS). The related electrical powers are too low to cause any ignition. In the case of PS2 and PS3, that is not the case leading to either arcing ignition (e.g. between two connector pins) or resistive ignition (e.g. by an overheating semiconductor component).

This classification and relation between power in a circuit and potential risk of fire is important since it can be a powerful Green Design guideline for engineers at an early step of a new application.

All possible Electronics connectors can be classified into internal and external connectors and will be described through the IEC recommendation on flame retardance. For internal connectors, designers can follow two different choices based on their own preference. They can either follow a "Prevent Ignition" path, or they can follow a "Control Ignition" path, both of which are viable options according to the IEC standard. Only one of them needs to be followed to provide the highest fire safety for electronic equipment.

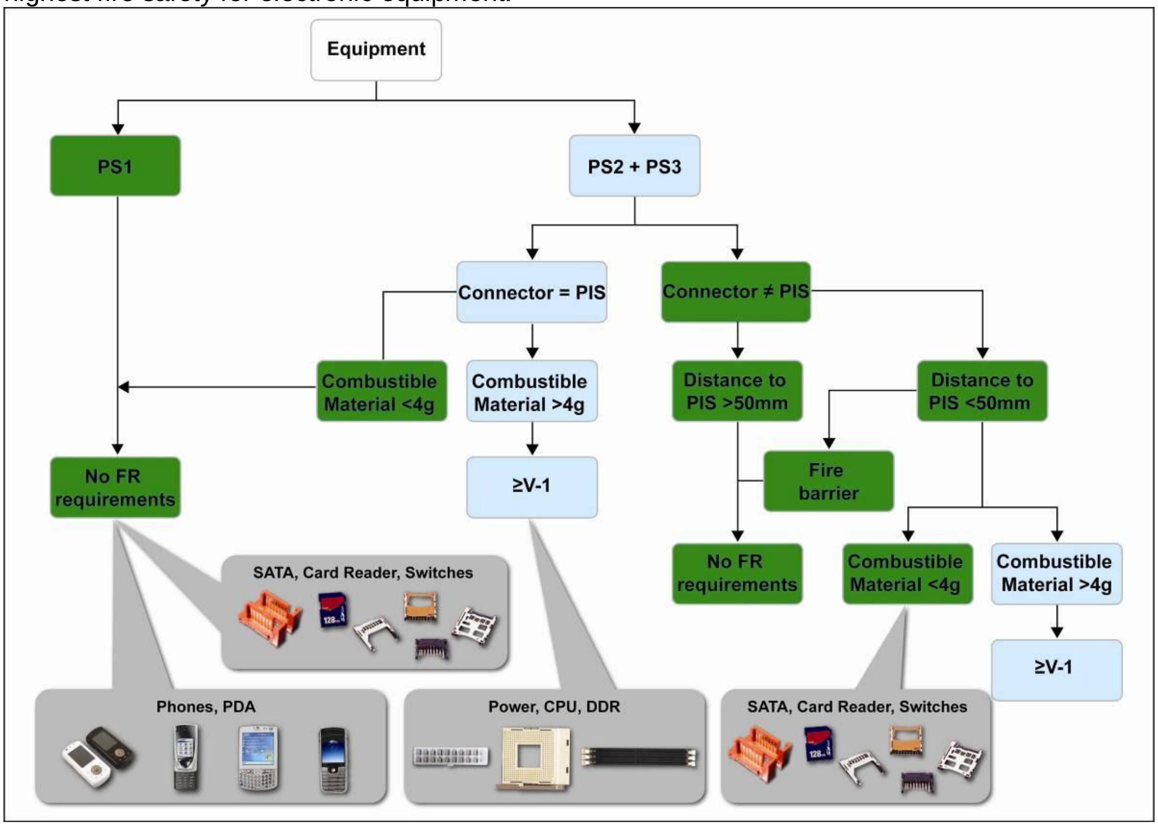

Figure 4: Prevent Ignition, internal connectors. Power level categorization and flame retardance requirements of internal connectors based on IEC62368 specification to prevent ignition. For illustration some connectors and applications are illustrated.

Let's start with the prevent ignition case: Figure 4 shows how to prevent ignition of internal connectors with some specific examples of the various cases. As is evident, the case with PS1 does not require any material with flame retardant. For all such low power circuits, the related internal connectors can have a UL94-HB rating. Such HB rated connectors of any shape, weight, color and manufacturer can be used in many different applications such as mobile phones, GPS Navigators, Cameras, MP3 players or PDAs. Following this recommendation allows an immediate implementation of Green Design.

Various such HB rated materials are available from many suppliers including DSM, worldwide leader in high temperature polyamides such as Stanyl®, and can be chosen by the equipment designer or connector manufacturer based on the required electrical and mechanical performance. As a result, designers will not only have immediate access to a green plastic suitable for high temperature ranges, but will also be able to capitalize on the best balance between mechanical, electrical, and flow performance. Such HB rated high temperature polyamides also have higher toughness, better UV stability, higher CTIs and does not add any additional system cost.

Since PS2 and PS3 have sufficient power to ignite a combustible material as the isolating plastic between connector pins, precautions need to be taken to prevent ignition. In this case, connectors/sockets are distinguished by the weight of the combustible plastic used.

Only in case the weight of the plastic in the connector is above 4g, the IEC recommends a flame retardance of at least UL94-V1. Typical examples are e.g. the main power connector of a PC or CPU socket.

There are also connectors/sockets within a PS2 or PS3 application, which are no PIS. This can be the case if multiple connector/sockets are connected to each other or if additional components such as converters are used in the circuit. In such a case of no PIS, the connector/socket can not ignite itself and the only source of an internal ignition remains ignition from a different component. Therefore, the key fire safety precaution is its distance to another PIS. If the distance is higher than 50mm, then such a connector/socket is outside any critical distances and can be designed in UL94-HB rated material, irrespective of it's weight. In case the connector/socket is within a critical distance of 50mm in proximity to another PIS, ignition can occur. If its weight is less than 4g, or if it should be located within a fire barrier, UL94-HB rated material can be used. In case the weight is higher than 4g, at least UL94-V1 needs to be used for the insulation material of such connectors/sockets.

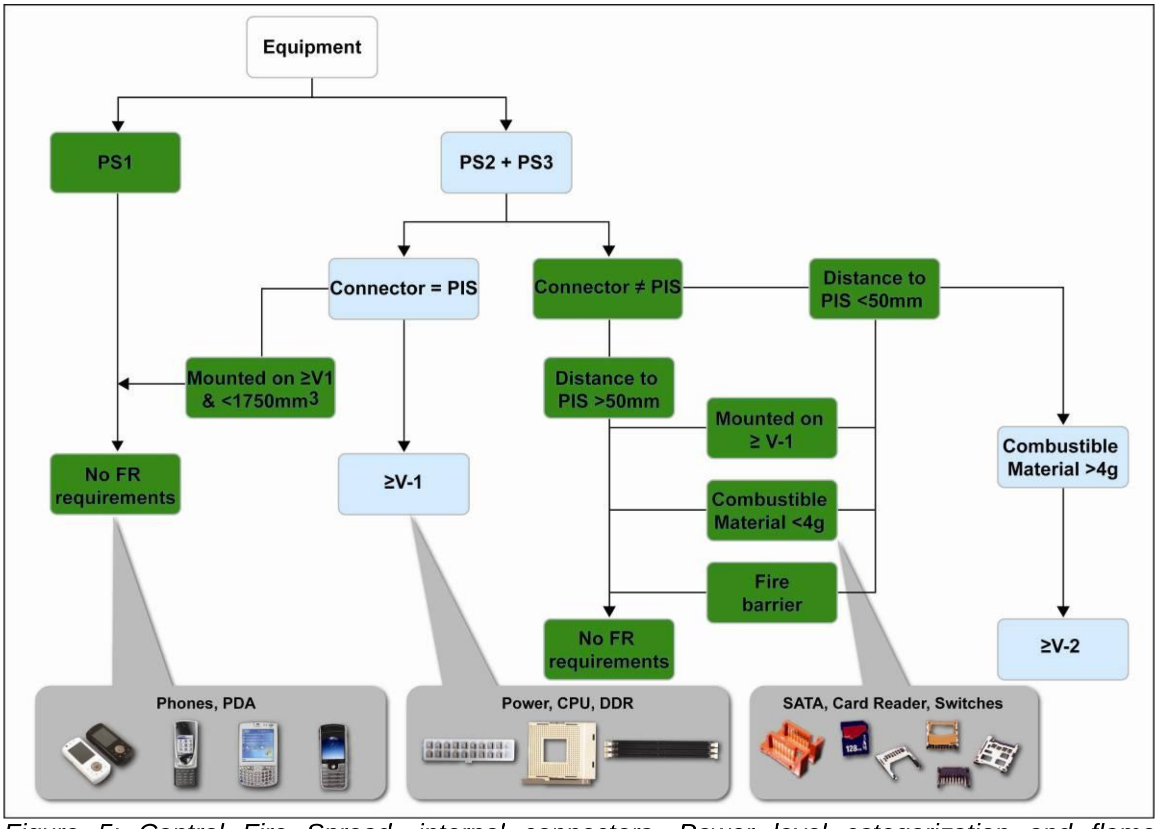

Figure 5: Control Fire Spread, internal connectors. Power level categorization and flame retardance requirements of internal connectors based on IEC62368 specification to control the spread of fire. For illustration some connectors and applications are illustrated.

Figure 5 shows a Green Design guideline to control the spread of a fire once a component has been ignited. While for PS1 circuits the IEC standard reveals a straight forward choice of UL94-HB material, a PIS in a PS2 or PS3 circuit is classified now by the volume of the connector and the flame retardance of the material where the connector/socket is mounted to. Since all standard PCBs are UL94-V0, the connector/socket can be UL94-HB if its volume is less than $1750mm^3$. If the volume is higher, then at least UL94-V1 should be taken. This is the case e.g. for CPU sockets.

In case of no PIS in a PS2 or PS3 circuit, UL94-HB can be selected by designers if the distance between it and another PIS is higher than 50mm. If the distance is smaller than 50mm, UL94-HB can be selected in all cases where the connector/socket is mounted on a better than UL94-V1 rated PCB, and same is the case if the weight of the combustible plastic in this connector/socket is lower than 4g or if a fire barrier such as e.g. a metallic housing should be present in its circuit. Designers sometimes use metallic housings to shield critical PCB areas against electro magnetic interference. These housings are typically also fire barriers.

In case no fire barrier is present for a no PIS connector and the weight of the connector is higher than 4g, then a flame retardance of at least UL94-V2 is recommended.

Note that there is a distinct difference between the two different options of preventing ignition and controlling its spread. It is the choice of the designer or the design policy of the manufacturer to choose one of these two options.

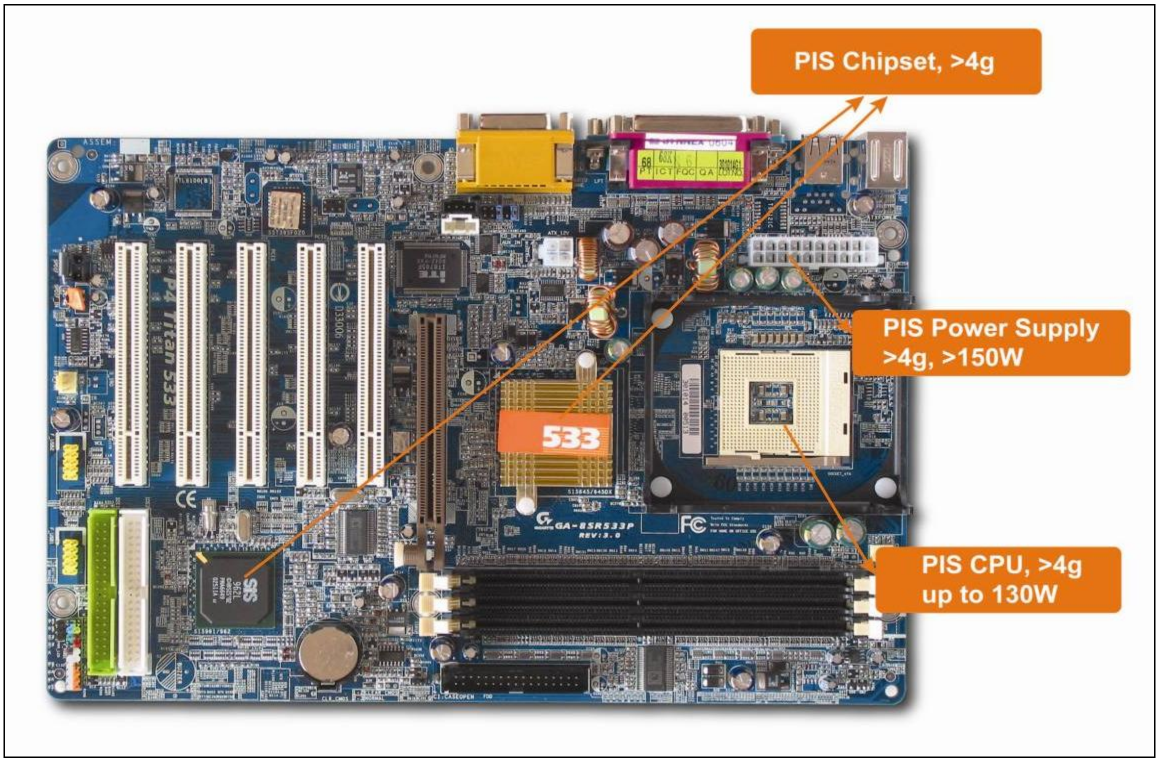

Figure 6: Available PIS in a typical application such as a PC mainboard. The distance to these areas can determine the required flame retardance of other components.

Figure 6 generically illustrates areas of PIS on a PC mainboard

Critical areas of high power are the main power connector, the CPU and the Chipset (South-and Northbridge). It is out of question that connectors and sockets used here must be at least UL94-V1. However, based on the IEC standard, connectors and sockets heavier than 4g and in proximity of 50mm around these PIS are of critical risk of igniting. The opportunity of increasing the distance to more than 50mm may be possible depending on the level of use of reference designs and also on the complexity and specifics of the application. For instance, the distance of the memory sockets to the graphics processor is very critical and increasing the distance due to the given space limitations in tight applications such as Notebook can negatively impact the data transmissions rates. OEM designers are experienced in this area and can estimate where these design opportunities exist. Where this option does not exist, we have seen designers seeking halogen free plastic solutions with UL94-V0 or V1 ratings. DSM's Stanyl with halogen free flame retardants have been sampled to many such OEMs and the results are very encouraging.

External Connectors

The new IEC62368 standard now also includes the safety standards required in the possibility of a fire caused by an already existing external fire such as a candle flame. With the continuously increasing presence of Electronics in our daily lives, driven by form and functionality, this is a good step that they have included this additional level of safety. Figure 7 depicts green design options for all external connectors which can come in contact with an existing flame.

The main parameter of interest here is the total weight of the combustible material in the chassis of the electronic equipment. If this weight is less than 300g, the IEC standard recommends the use of UL94-HB material for all such external connectors. Typical application examples are all mobile phones, cameras, PDAs or GPS navigators where we have seen that these equipments' plastic chassis is 150g or less. If the weight of the chassis is above 300g, the IEC standard recommends the use of at least UL94-V1 flame retardance for external connectors.

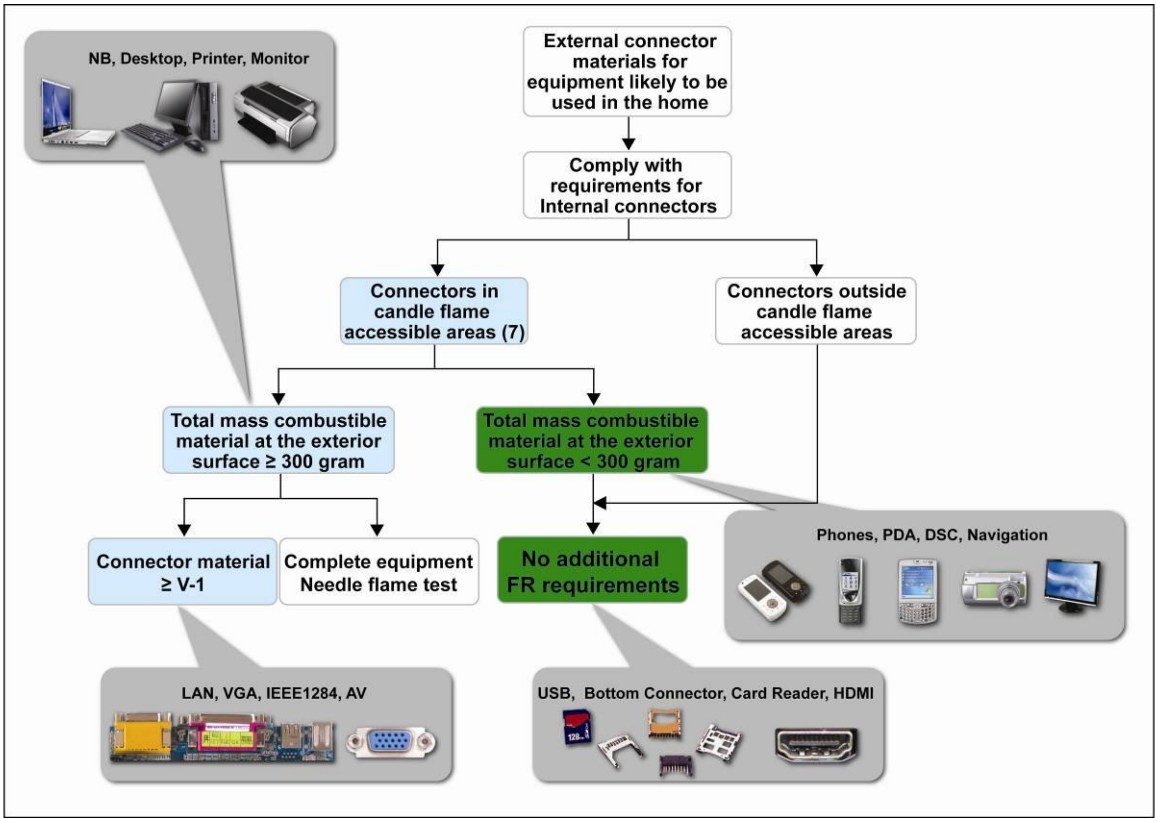

Figure 7: Flame retardance requirements of external connectors based on IEC62368 specification, for illustration some connectors and applications are illustrated.

Conclusions and emerging trends

We believe that the new IEC62368 will lay the future implementations of adequate standards of safety and avoid potential product over specifications at early stages of design. As a material selection criterion and in terms of design guidelines, this can greatly help OEMs to implement Green Design.

The mobile phone industry has been one of the first in the electronics industry to make this change to halogen free using these new standards. In 2006, we saw the first major mobile phone company adapting to this new standard of using Green Design. A year ago another major manufacturer joined and now after just two and a half years after the start of the trend, almost all major mobile phone manufacturers are applying these changes on flame retardance for their connectors in specific application context rather than one generic specification across the board.

With the further penetration of halogen free plastics it is therefore not surprising, that now also the first Consumer and Computer OEMs are looking into this IEC specification which enables designers to choose connector specifications fitting their applications. Avoiding such over specification enables them to avoid cost increase in contrast to other companies which face significant price increase in addition to potential material availability issues with the move to plastics with halogen free flame retardants.

We are confident, that such guidelines will not only preserve the same high levels of safety, but will enable a fast track move to cost effectively realize Green Design.

DSM Engineering Plastics

DSM Engineering Plastics is a Business Group in the performance materials cluster of DSM, with sales in 2007 of EUR 839 million and approximately 1550 employees worldwide.

It is one of the world's leading suppliers of engineering thermoplastics offering a broad portfolio of high performance products including Stanyl® high performance polyamide and Akulon® 6 and 66 polyamides, Arnitel® TPE-E, Arnite® PBT and PET polyesters, Xantar® polycarbonate, Yparex® extrudable adhesive resins. These materials are used in technical components for electrical appliances, electronic equipment and cars, in barrier packaging films as well as in many mechanical and extrusion applications. With Stanyl®, it is the global market leader in high heat polyamides.

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