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Dual-Use Legislation and MLCCs

APPLICATION NOTE

This application note explores the details of dual-use trade controls, how to determine if your MLCCs could fall under this regulation, and what you need to do to stay in compliance.

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Dual-Use Legislation and Multilayer Ceramic Capacitors

ABSTRACT:

Today, many electrical systems are demanding higher operating voltages and temperatures, along with higher capacitance values – particularly in the fast-growing area of power electronics for electric vehicles (EVs). Therefore, electrical design engineers are looking to use multilayer ceramic capacitors (MLCCs) in these applications due to their inherent low inductance and wide operating temperature range. However, this potentially perfect component could bring manufacturers and distributers into conflict with international export law if you are not careful. This application note explores the details of dual-use trade controls, how to determine if your MLCCs could fall under this regulation, and what you need to do to stay in compliance.

WHAT IS DUAL-USE LEGISLATION?

Dual-use legislation is an international law and most, if not all, countries have included it in their export regulations. Organizations such as the European Commission, the U.S. Department of Commerce's Bureau of Industry and Security, and China's Ministry of Commerce are some of the governing bodies that define dual-use legislation in their respective countries. In short, these organizations consider goods, software, and technology to fall under dual-use legislation if the product can be used for both civilian and military applications. If it can be used for either purpose, the product will then require further review to determine if it meets the stipulations in that country for needing an export license.

It is important to note that Dual-use legislation considers the actual end-use of the component irrelevant. It is a common misconception that dual-use legislation only applies to components that are designed or intended for military use. If the component meets certain characteristics, it is export restricted. Simply put, the component does not have to be intended for use in a military application, only capable of being used in one. Therefore, you cannot disregard dual-use legislation just because your application is commercial.

HOW DUAL-USE LEGISLATION COULD IMPACT YOUR USE OF MLCCS

Let's consider this real-world example of how dual-use legislation could impact an EV application. When designing an EV invertor, you need to use smoothing capacitors. These capacitors are traditionally leaded plastic film and installed into plated through holes. However, from an assembly point of view, this is inefficient. Surface mount technology, such as MLCCs, would be a better option since MLCCs have much lower inductance than film. MLCCs also have a higher temperature rating, which means these capacitors can be moved closer to the critical circuits and a lower capacitance can be used.

Unfortunately, a single MLCC cannot offer the very high (≥10µF) capacitance needed for this application. To overcome this, several MLCCs need to be mounted in parallel, and to minimize the number of parts needed, the highest possible value for the MLCC needs to be specified. A typical working voltage of around 450Vdc with AC ripple on top means a 1kV rated part is necessary to meet these needs and provide a margin of safety. Therefore, an AEC-Q200 certified 1µF 1kV rated MLCC, dielectric type X7R, case size 3640 with inductance of ~2nH might be ideal.

While this part will technically meet the specifications required for this example, using this part could be challenging as international dual-use regulations may potentially make this part export restricted. This is because dual-use legislation for capacitors cascades from the Nuclear Suppliers Group (NSG) and relates to components that could have a use in military hardware under classification 3a201a2. More specifically, the NSG guidelines include that (6.A.4) dual-use status applies to pulse discharge capacitors having either of the following sets of characteristics:

1. Voltage rating greater than 1.4 kV, energy storage greater than 10 J, capacitance greater than 0.5 µF, and series inductance less than 50 nH.

2. Voltage rating greater than 750 V, capacitance greater than 0.25 µF, and series inductance less than 10nH.

MLCCs can potentially fall into category two even if the capacitor is not classified as a pulse discharge capacitor. This is because the NSG does not define pulse discharge and there is not a clear definition of what is meant by this term. For example, is a capacitor pulse-discharge because it is designed to be, or because it is capable of being one? A standard X7R MLCC may be used as a pulse discharge, irrespective of whether it was intended to be used as one.

Most countries have avoided this issue by translating the NSG ruling into law without the words "pulse discharge," taking the definition supplied by the NSG to be a suitable way of defining a pulse-discharge capacitor itself. This makes legislation easier to apply as it relates to all capacitors of any type.

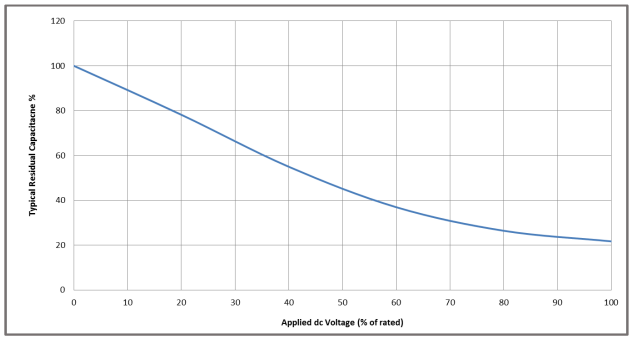

Figure 1 – A typical voltage/capacitance curve for high-value/ high-voltage X7R dielectric MLCC.

Even if a capacitor with a voltage rating of 750Vdc and <250nF is selected, the situation is not 100 percent clear if dual-use legislation will apply since the ruling has been clarified that the capacitance value cut off is 250nF *when measured at 750Vdc*. As shown in Figure 1, the capacitance value of type II ceramic dielectrics such as X7R drops considerably with applied voltage. This means the aforementioned 1kV 1µF MLCC may be perfectly OK to use without dual-use legislation applying, as long as the actual capacitance value drops below 250nF when 750V is applied.

Similarly, one must consider the opposite possibility. While most MLCCs have a negative voltage coefficient of capacitance, some positive coefficient types are now available. These capacitors can have a much higher effective capacitance at 750V than their headline stated value at 0V, making it hard to determine if a part is export restricted from the part number alone.

The manufacturer of the MLCCs should be able to confirm if a part could be considered dual use and be able to provide graphs to back-up the statement if necessary. In general, parts with a rated voltage <750V will be OK and not fall under this regulation. However, for any MLCC that has a suggested use that is acceptable at a higher voltage than the declared rating, this could be seen as a way of trying to avoid the law and may incur penalties for any party who moved a part across a border.

STAYING IN COMPLIANCE WITH DUAL-USE REGULATIONS WHEN USING MLCCS

To avoid potential issues with dual-use regulations, circuit designers could consider a radial leaded MLCC. These MLCCs are covered by the legislation but fall in a grey area as the inductance depends where on the lead you take a measurement. Leads are usually around 1” to 1.5” (25mm to 37mm) long and have their own inductance. When inductance is measured at the end of the lead, the part would probably exceed 10nH, but next to the body, it would be much lower.

It may seem that you could also reduce the individual component value below the threshold and mount capacitors in parallel on the board, as long as the board serves another use such as being the main electronics board as well. This is routine practice and will give the same result as using a higher value capacitor, but this will come at the expense of board real estate.

However, if the capacitors are put in parallel on a board that is used specifically just for this purpose, or the capacitors are arranged together in an assembly using metal busbars or lead frames (e.g., a ‘stacked’ capacitor), then the defining characteristic becomes that of the assembly and

the board or assembly will be considered as a single capacitor. In these cases, the overall inductance of the assembly needs to be taken into account.

While most countries demand a license for each export of a component that falls under this regulation, if the component originates in the USA, the administration allows for exports to the EU, Japan, Australia, Korea, and New Zealand without licences, but exporting to China and India would require a license. Obtaining a license is a relatively simple procedure, but it takes time and requires details of the end use to be submitted to the authorities.

Additionally, each country that requires licensing has its own procedures, and some are more flexible than others. Parts can still go through distribution, but generally cannot be sold on the open market, and each application will usually require its own license. Parts also typically cannot pass through multiple countries as each border crossing usually demands a new license. This means it may be the responsibility of the exporter to apply for the license, which could be the distributor, not the manufacturer. It is worth noting that there are some exceptions to this requirement such as free trade areas or countries that allow short-term import and re-export.

Don’t Let Fears of Dual-Use Legislation Hold Back Your Innovation

As power industries and EV manufacturers continue to push boundaries when it comes to operating voltages and temperatures, R&D engineers are trying hard to increase the energy storage capacity per unit volume and increasingly turning to MLCCs. As a result, in the next few years, we believe we can expect to see new dielectrics and larger case sizes, which means components regulated by dual-use legislation will become even more common.

As shown throughout this application note, dual-use export regulations cannot be ignored as ignorance of the law is not a good defense, and the penalties for breaching this regulation are severe. By working closely with your suppliers and all the partners in your supply chain, the potential requirements of this regulation are manageable. Just be sure that any company involved your supply chain is aware of this legislation and can consider the possibilities of components falling under this regulation at an early stage.