Advances in EMI Circuit Board Shields

Shielding performance and installation challenges can be met with circuit board shields.

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INTRODUCTION

Electromagnetic interference (EMI) is electromagnetic energy that adversely affects circuit performance in electronic devices such as hand-held portable cellular telephones or personal computers. Many types of circuits are susceptible to EMI and must be shielded to insure proper performance. In the case of hand-held portable cellular telephones, emissions radiating from the telephone circuitry may threaten nearby circuits within the telephone enclosure. This requires compartmental shielding of various sections of the telephone circuit board.

Government agencies, such as the FCC in the U.S., CSA in Canada, and IEC in Europe, set specific requirements with regard to allowable EMI emissions on electronic devices. In layman's terms, this means that an electronic device cannot affect the performance of another electronic device in a known broadcast spectrum frequency. Future guidelines will include susceptibility standards as well. These new standards mean that electronic devices cannot be affected by any other electronic device. One example is the current airline restriction against using laptop computers on a plane during takeoff. The electronic hardware in the plane may be susceptible to the radiated emissions from the computers, and serious malfunctions could occur due to unwanted electromagnetic interference.

In this fast-paced world of electronic devices, traditional methods of meeting EMI/RFI shielding specifications have been found to be piece-part costly, labor intensive, and environmentally questionable. In an effort to meet today's shielding challenges, many manufacturers of electronic devices utilize surface-mountable modular metal shields that are packaged for automated installation using standard pick-and-place installation equipment. These board-level installed shields can sometimes replace traditional shielding methods, such as conductive paints or metallizing on plastic enclosures and conductive interface gaskets.

SHIELDING

EMI shielding is generally defined as the use of conductive materials to reduce electromagnetic interference by absorption or reflection. Modular metal circuit board shields combine both absorption and reflection characteristics. Tin-plated steel, a typical surface-mounted shield substrate, has excellent absorption due to the magnetic permeability of the ferrous materials in the shields, especially in the lower frequency ranges, as well as excellent reflection characteristics due to the conductive nature of the shield at the higher frequency ranges.

How well a shield reduces the energy of, or attenuates, a radiated electromagnetic field is referred to as its shielding effectiveness (SE). The standard unit of measure of shielding effectiveness is the decibel, or dB. The dB value is the ratio of two measurements of an electromagnetic field, one before and one after shields are added. For every 20 dB increase in shielding effectiveness, a tenfold reduction in EMI leakage is measured through a shield. A 60 dB shield, a not uncommon requirement, attenuates field strength by a factor of 1,000 times. Shields are also used when attenuation of just a few dB is required. Each application can be addressed individually, with an appropriate design configuration developed to meet the need.

Most important to the shielding effectiveness of surface-mounted circuit board shields is the termination to the circuit board. This happens when the circuit board travels through the reflow ovens, melting the solder pad on the board, causing the solder to wick up onto the shield. Flatness, or co-planarity of the shield is paramount to the proper termination. The most effective circuit board shields are made to exacting tolerances for co-planarity, with .002-.004 inches a general rule of thumb. An industry standard for measuring these products requires using state-of-the-art computerized visual measuring equipment. Standard measuring procedures include multiple test points per shield, when combined in groups of three, to create a plane. A "best plane" is determined from these points. This plane is then compared to all measured points per shield for lack of conformity, and to confirm co-planarity.

INSTALLATION CHALLENGES

High costs of installation are a problem today's manufacturers face when addressing shielding concerns. Surface-mounted circuit board shields are especially packaged in tape and reel form or anti-static pick-and-place tubes for

automated installation to reduce costs. The shields are mounted directly on the circuit board, using standard pick-and-place installation equipment, the same equipment used to install other surface-mounted components, and are soldered directly to ground paths which complete the termination. This occurs during normal solder reflow operation, resulting in a "Faraday Cage" shielding effect.*

Most circuit board shields are designed to allow for heat penetration during this process, enabling components located beneath the shield, as well as the shield, to become properly heated and installed at the same time, in one pass. Multiple shields can be installed on a single circuit board, permitting more components to be placed on the board, and reducing overall size, which is very important to manufacturers of telephones, PCMCIA cards, computers, and other electronic products. These shields can be made to almost any size or shape, to meet any design requirement.

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The current automated packaging formats follow Electronic Industry Association and JEDEC standard specifications, but also allow for custom sizes that exceed or do not meet the existing dimensional standards. This allows manufacturers to install shielding products with automated equipment, with no modification necessary. Installation can be completed by adding a reel of surface-mounted circuit board shields to existing manufacturing equipment. By following proper installation instructions, installing surface-mounted EMI shields is no different than installing surface-mounted semiconductors or other surface-mounted electronic components. Studies show that automated installation of surface-mounted components increases the reliability of electronic devices and increases the throughput on the manufacturing side as well.

Surface-mounted shielding products offer flexible design options which can be adapted to almost any situation. Traditionally, surface-mounted circuit board shields are designed to meet a specific need, either electrical or mechanical. Any available metal substrate, including beryllium copper, aluminum, and mu-metal can be incorporated into a design. These materials are manufacturable in practically any size or shape, depending on application.

Surface-mounted circuit board shields can be manufactured to exacting tolerances in unique shapes and sizes, and must be clean and free from contaminates and oils which are sometimes part of the manufacturing process. Proprietary aqueous cleaning agents which have no effect on the environment are commonly used to eliminate the contaminates.

In order to attain proper shielding, plastic housings must be manufactured using intricate multiple compartment designs. These difficult-to-make housings are considerably more expensive than a standard snap-together design. A simple, cost-effective snap design, using little closure force, can be used when combined with surface-mounted circuit board shields. Reduction in overall design time, installation costs, and increased reliability can be achieved using this method.

Surface-mounted circuit board shields also add strength to the circuit board itself. With increasing mechanical test requirements on electronic devices, the additional strength allows for a more rugged device, with little or no added cost. An automotive electronic control is an example of a device which must pass strict mechanical requirements.

CONCLUSION

Using a modular metal surface-mounted EMI shielding system has enabled major manufacturers of electronic devices to reduce design time, lower piece-part prices, lower overall installed costs, eliminate environmentally questionable conductive paints and limit the need for conductive gaskets. Increased product strength along with productivity and higher quality can be achieved as well. Surface-mounted circuit board shields also meet today's environmental requirements. The ability to mass-install these shields, using standard installation equipment makes these products a modern, practical way to achieve shielding results.

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*A Faraday cage is a six-sided metal box with no seams or openings, and is generally considered the optimum, although impractical, shielding enclosure.