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DOCUMENT DESCRIPTION
ESD Control Document, Ethernet Chassis Ground Plane

SMSC™ SUCCESS BY DESIGN

LANCheck DESIGN CHECK SERVICE

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PCB ESD Design Guidelines

Designing for ESD success must be considered during the schematic design and the PCB design cycles within the overall product design cycle. ESD design violations are especially critical to any Ethernet product simply due to the relationship between an Ethernet enabled device and ESD testing. ESD energy can be generated from several sources and then, injected into the application. This ESD energy will attempt to infiltrate the system through any opening in the metal enclosure or at any cable making a system connection.

The Ethernet Chassis Ground System

This paper and the following diagrams help to explain the importance of utilizing a chassis ground system in an Ethernet enabled product. Any product with an Ethernet port may be exposed to high-energy sources. This high energy can enter the system through the Ethernet cable, a direct touch to the metal enclosure, or a spark gap touch to the metal enclosure. Obviously, the main intent here is to restrict any abnormal high-energy pulses from the digital ground plane and the digital power planes of the PCB. These high-energy pulses can cause erratic system behavior and/or cause semiconductor damage.

This high energy can enter into the CAT-5 Ethernet cable in two ways. There are eight wires inside the CAT-5 cable. They are grouped into 4 pairs. The Ethernet port actively uses two pairs. The other two pairs are unused in the cable.

If high energy were to enter the system through the unused wires, there is a path to Earth ground to address this problem. The unused pairs in the cable are terminated at the RJ45 connector (pins 4,5 & 7,8). These pins are typically resistively connected to a high voltage capacitor (2KV) to Chassis ground of the PCB. This Chassis ground on the PCB is then directly connected to the metal enclosure of the product. This path then continues through the power supply, through the power cord to Earth ground. Any high voltage entering on the unused pairs passes harmlessly to Earth ground.

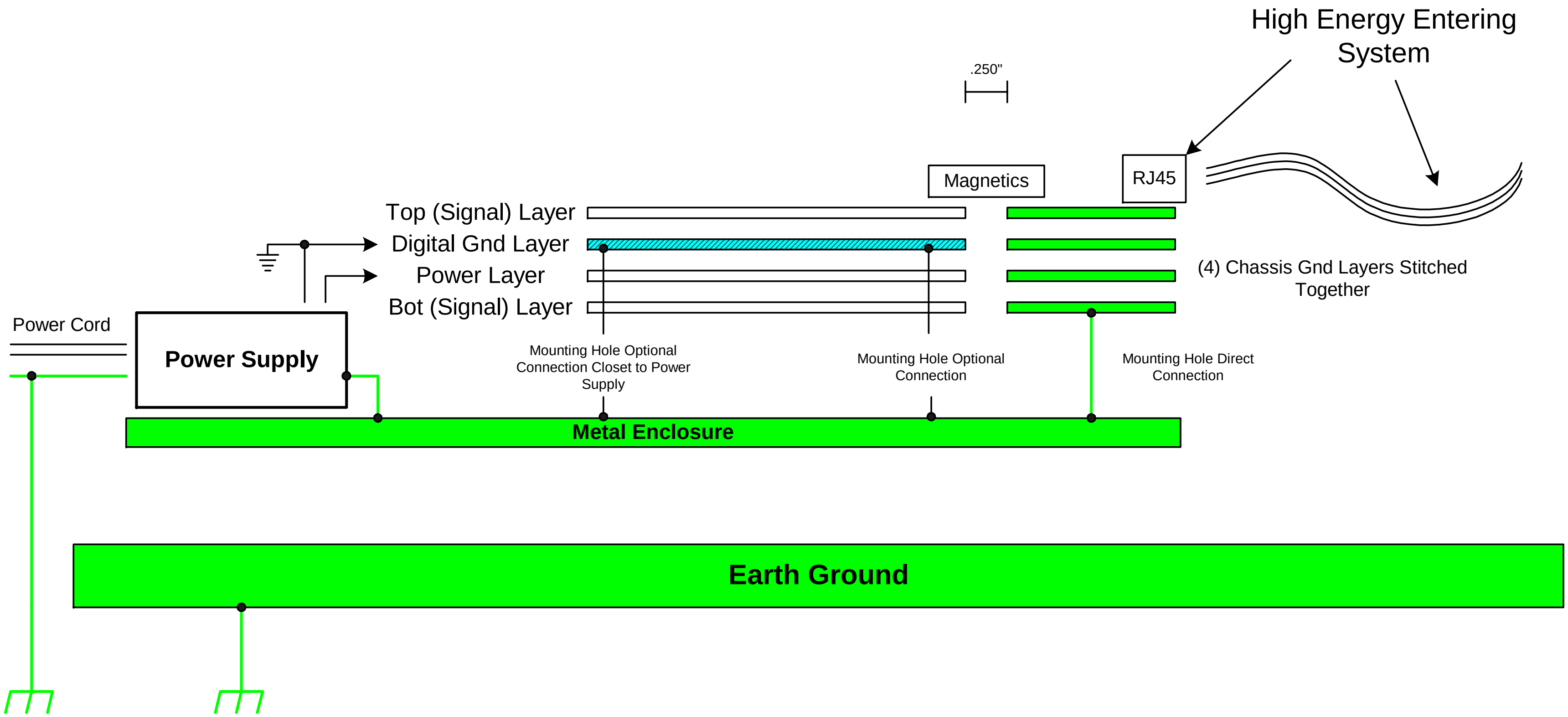
High energy may also enter the system through the active pairs of wires in the CAT-5 cable. These wires are handled in a different manner. These pins on the RJ45 connector are 1,2 & 3,6. This path involves allowing the high energy to enter the Ethernet magnetics. The magnetics are rated for a high breakdown voltage. The unwanted high energy exits the magnetics through the cable side center taps of the magnetics. These points are typically resistively connected to a high voltage capacitor (2KV) to Chassis ground of the PCB. This Chassis ground on the PCB is then directly connected to the metal enclosure of the product. This path then continues through the power supply, through the power cord to Earth ground. Any high voltage entering on the active pairs passes harmlessly to Earth ground.

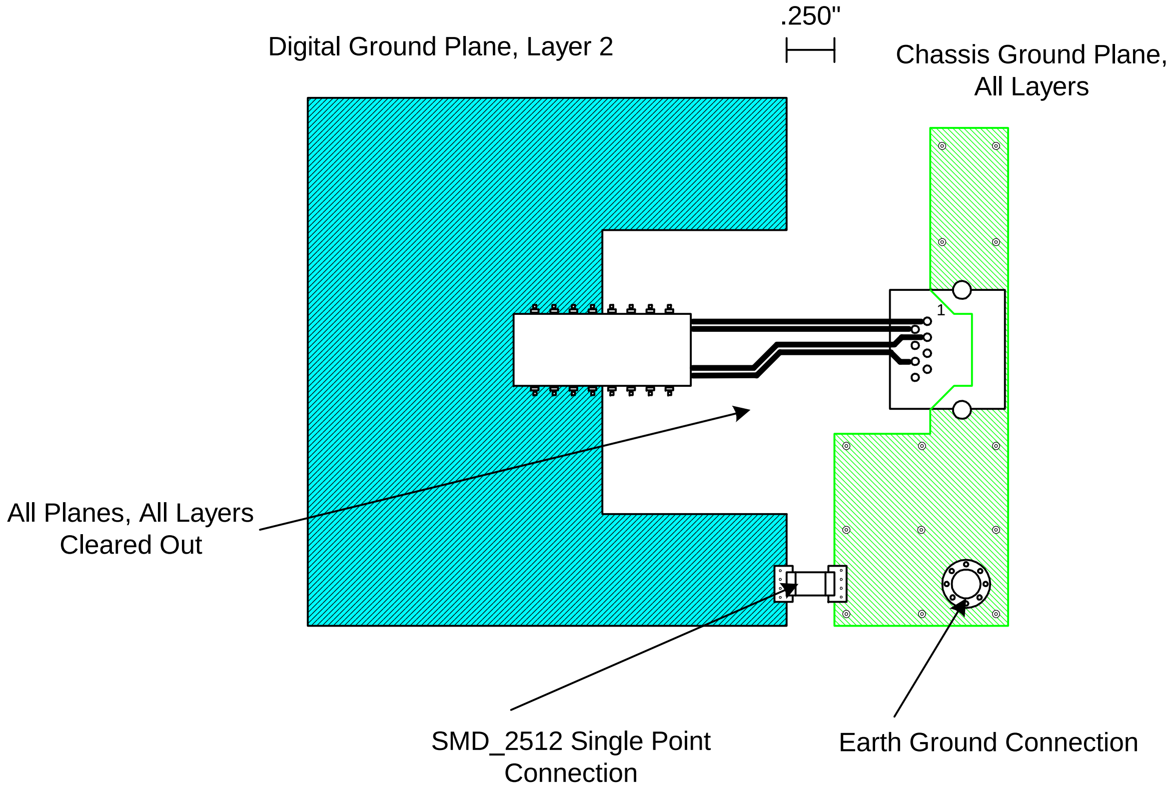
If a person were to approach the electronic equipment and discharge energy into the metal enclosure (spark gap), the same path to Earth ground is utilized. The charge passes from the metal enclosure through the power supply, through the power cord to Earth ground.

The same path safely steers any direct high voltage contact to the metal enclosure. The charge passes from the metal enclosure through the power supply, through the power cord to Earth ground.

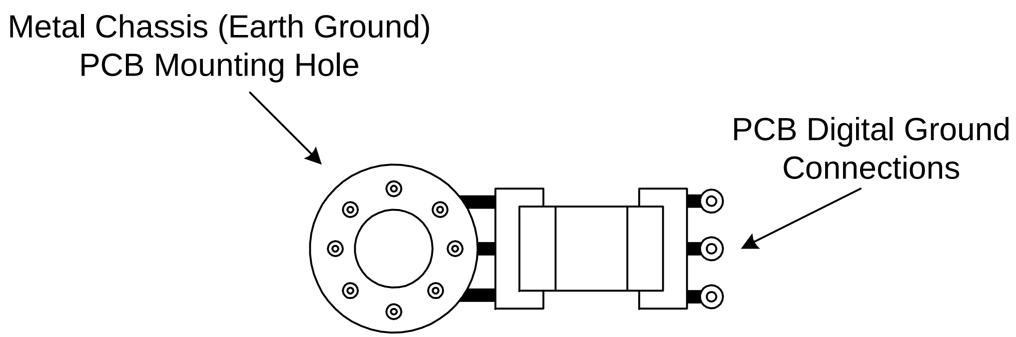
In referencing the following illustration, one realizes that none of the above four intrusions ever enter the digital power planes or the digital ground planes. The PCB Chassis ground along with the Ethernet magnetics provides complete isolation for the system from the outside world. Around the RJ45 connector is a completely separate Chassis ground plane system. This Chassis ground is connected directly to the metal chassis of the electronic product. This provides the lowest impedance to Earth ground. There should be at least a .250” gap between the PCB Chassis ground planes and all other planes, traces and components. This will afford the best isolation performance from the product.

Connections from the digital ground plane in the isolated section of the PCB to the metal enclosure are open to interpretation. These connections will depend upon the designer’s desire, the testing the equipment is subjected to and radiated EMC variations. The best approach for the mounting holes in the PCB in the digital ground section is to design them with a SMD footprint option. Each mounting hole should have a large SMD footprint connecting the mounting pad to digital ground. With this option, the designer can leave the footprint blank leaving the digital ground plane completely isolated from the metal enclosure (i.e. earth ground) (typical application). Or a high voltage capacitor can be installed in the footprint to AC couple the digital ground plane to the metal enclosure. Or a zero ohm resistor can be installed in the footprint to make a direct connection to the metal enclosure (atypical application). The designer may discover an apparent difference in performance characteristics by treating the mounting hole closest to the power supply differently then all the other mounting hole positions. This approach affords the design engineer flexibility in the configuration of the system grounding.


High Energy Entering System
.250"
Magnetics
RJ45
Top (Signal) Layer
Digital Gnd Layer
Power Layer
Bot (Signal) Layer
(4) Chassis Gnd Layers Stitched Together
Power Cord
Power Supply
Mounting Hole Optional Connection Closet to Power Supply
Mounting Hole Optional Connection
Mounting Hole Direct Connection
Metal Enclosure
Earth Ground



Top View, Digital Ground Plane and Chassis Ground Plane Relationship



Detail of Floating Mounting Hole with Option for Digital Ground Connection