TE Connectivity SFP+ Stacked Cage EMI and Thermal Enhancements

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Abstract

As pluggable I/O data rates increase, the need to effectively limit EMI emissions and heat generated by fiber optic transceivers simultaneously arises. Typically this is done through an EMI containment vehicle such as a sheet metal cage or die cast housing. This article will focus on I/O connectivity solutions that address both EMI containment and thermal performance issues in order to provide a state-of-the-art solution to TE Connectivity's communication and networking OEM customers

Background

This article highlights TE's SFP+ 2xN stacked connector offering, which uses a sheet metal construction, and the enhancements made to them to increase EMI containment and thermal performance.

As the communications industry pushes for ever increasing data rates and increased bandwidth, there are two traditional methods for meeting this demand. The first is to increase port density using existing SFP transceivers. The second method is to use newer higher data rate (10-14 Gb/s) SFP+ optical transceivers in order to reduce port density and increase bandwidth. Both of these options pose EMI and thermal performance concerns, and many competing factors need to be considered.

There are many variables that affect EMI emissions such as leakage from optical transceivers, type of board-level components (integrated chips, power supply module, etc.), and other improperly shielded connectors used in today's communications equipment. If these EMI emissions are not properly contained within a chassis, then these disturbances may degrade or limit the effective performance of the electrical circuit or prevent the end product from passing FCC emissions standards. These effects can range from a decrease in performance to a total loss of data transmission.

There are also many internal and external variables that affect thermal performance of pluggable I/O products and dictate whether or not a cooling solution is required. Unfortunately there is no clear answer to this question and therefore system architects must consider many options and restrictions when designing end products.

The form factor of the product must be taken into account as different configurations have unique airflows. A "pizza box" (whether a 1U or 4U) that is mounted in a standard rack may have front-to-back airflow or side-to-side airflow. A blade style switch, or piece of equipment, may be mounted vertically within an enclosure that is in turn mounted in a standard rack. This type of configuration almost always has bottom-to-top airflow.

The number and density of ports mounted to the PCB must also be well thought out. These ports can be single port cages, 1xN ganged cages, 2xN stacked cages or a combination of all three. This is in addition to other I/O connectors at the face of the product. The spacing between these cages must also be taken into account as well as port density, ambient air temperature, airflow, allowable temperature rise and backpressure created by baffling.

Finally, heat dissipation of the optical transceiver itself must be considered. Older SFP optical transceivers usually operate at lower wattages but newer SFP+ optical transceivers are operating at higher wattages. Commercially available optical transceivers are rated up to 70°C but there are extended temperature range transceivers that can operate up to 85°C. Newer SFP+ modules that are used in short reach and long reach applications are still dissipating 1 watt or less but extended reach and fixed DWDM (dense wavelength division multiplexing) transceivers can range from 1.25 to 1.5 watts per port.

The industry has found that trying to cool these higher wattage transceivers in SFP+ stacked cages is quite challenging. Managing the temperature of the inner lower row of ports that are not exposed to airflow is especially difficult. The following paragraphs will provide information as to how TE has enhanced SFP+ stacked cages to meet both EMI and thermal performance challenges.

te.com/products/SFPplus

EMI Enhancements

Through extensive research and testing, TE engineers have redesigned two components to improve EMI performance. The first component identified was the gasket retention plate shown in Figure 1. This component acts as a backer plate for the conductive elastomeric gasket that interfaces with the inside of the front bezel. This retention plate was redesigned to utilize a right angle design with more attachment points to the cage body. These additional attachment points minimize the chance for EMI emissions to escape between the cage body and gasket retention plate. The redesigned gasket retention plate can be seen attached to the cage body in Figure 2.


Figure 1: Standard gasket retention plate

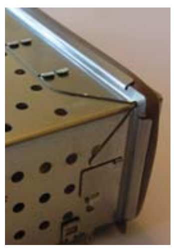
Figure 2: Right angle gasket retention plate

The second component that was identified for improvement was the latch plate, which is the component that separates the bottom port from the upper port. This component also houses the lightpipes that transmit light from LEDs mounted on the PCB to the front face of the cage assembly. Industry standards dictate the design of the latching mechanism so this was left unchanged, but within the latch plate a secondary component was added to improve EMI performance and prevent leakage. Since this component is integral to the cage body there is no difference in appearance or functionality between standard SFP+ stacked cages and SFP+ stacked enhanced cage assemblies. See Figure 3 for detail view of latch plate.

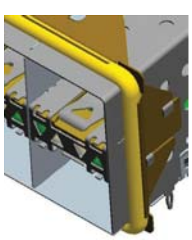
Figure 3: Detail view of stacked cage with four lightpages in latch plate

The optimization of the gasket retention plate and the addition of the component to the latch plate yielded a significant improvement in EMI performance in the 10-15 Ghz range. Test results shown in Figure 4.

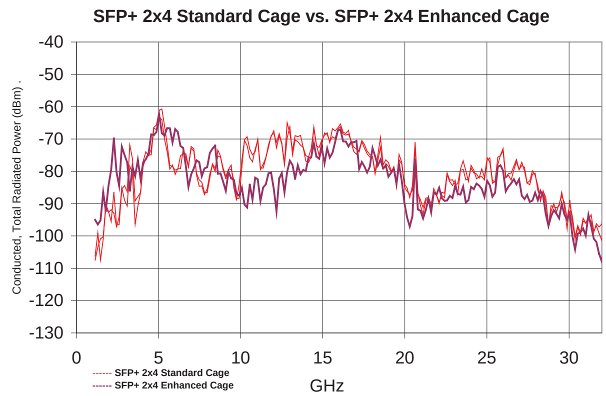

Figure 4: EMI test data comparing standard SFP+ stacked cages vs. SFP+ stacked enhanced cages

Thermal Enhancements

The real estate that the latch plate provides was also used to create an airflow channel throughout the cage body in order to allow for the cooling of the lower row of SFP+ ports. This included the addition of square shaped perforations to the outside cage walls and vertical port separators, as well as two thermal vent holes in the front of the latch plate. These perforations were optimized in size and shape in order to maintain the same improved level of EMI performance, and the two thermal vents holes added to the front of each latch plate still allow for the use of two lightpipes per column ..See Figures 5 and 6 for a side view of cage assembly that includes side wall perforations, and for a detailed view of latch plate that includes the two thermal vent holes.


Figure 5


Figure 6

Standard SFP+ stacked 2x4 cages were tested in order to establish baseline test data which would be compared against thermally enhanced cages. The test setup consisted of three cages mounted to a mock PCB with half-inch spacing between each cage. The PCB was then placed within a wind tunnel that allowed the front face of each cage to protrude thru a bezel. Each port was simultaneously populated with a modified SFP+ module that allowed the use of thermocouples for measurement data and allowed testing of various wattages. Thermocouples were also attached to the top, sides, and back of cage to record surface temperatures. An adjustable baffle was added to the exit end of the wind tunnel to induce backpressure.

The following parameters were used for the baseline testing and follow up testing with enhanced cages:

- Airflow: 500 LFM (as measured by airflow chamber and not by anemometer probe)
- Backpressure: 0.25 inches of water (controlled by baffle)
- Altitude: Sea level
- Temperature: Room ambient (results adjusted for 55° C ambient)
- Power: 1.5 watt per transceiver
- Air gap above cage: 50mm
- Air gap below PCB: 9.5mm
- Temperature rise limit: 70° C

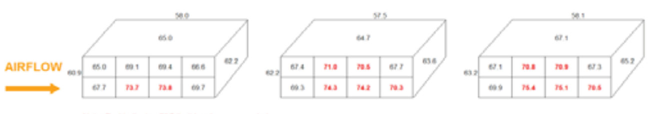

Figure 7: Test data for standard SFP+ stacked 2X4 cages

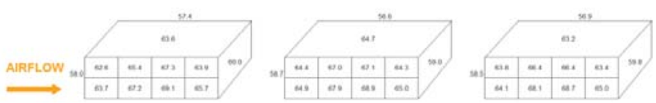

Figure 8: Test data for thermally enhanced SFP+ stacked 2X4 cages

TTest data using 1.5 watts per transceiver indicates thermally enhanced cages outperform standard SFP+ cages by a 3% reduction in temperature, in this particular test environment. This testing also verifies that the lower inner row of ports is the most difficult to effectively draw heat away from and will remain a challenge as data rates continue to increase. TE's thermally enhanced 2xN cages include the same EMI enhancements mentioned above. More information can be found at www.te.com/products/sfpplus, including links to catalog, eLearning module, Quick Reference guide and product presentations.