THE ELECTRONIC CONSIDERATIONS OF EMBEDDED PASSIVE COMPONENTS IN OPTICAL PCB FABRICATION

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Surface Based Optical Transmission

The current technology includes transmission of between optical units (typically modulated laser sender and receiver units) and fiber optic cables or flexible kapton fiber optic cables with which we are all relatively familiar.

Methods for forming and connecting fiber optic systems are well developed. The primary new developments in this area may be in modulation and multiplexing techniques and connection methods.

At present the optical and digital devices may be mounted on opposite sides of the PCB for optimum design and all connections are on the surface of the PCB.

The limitations for this technology for on board transmission of signals are size, surface space requirements, and limited channels available. As can be seen in Figure 1, no decided advantage may be realized in the inclusion of embedded passives in this type of architecture beyond those advantages seen in any multilayer structure.

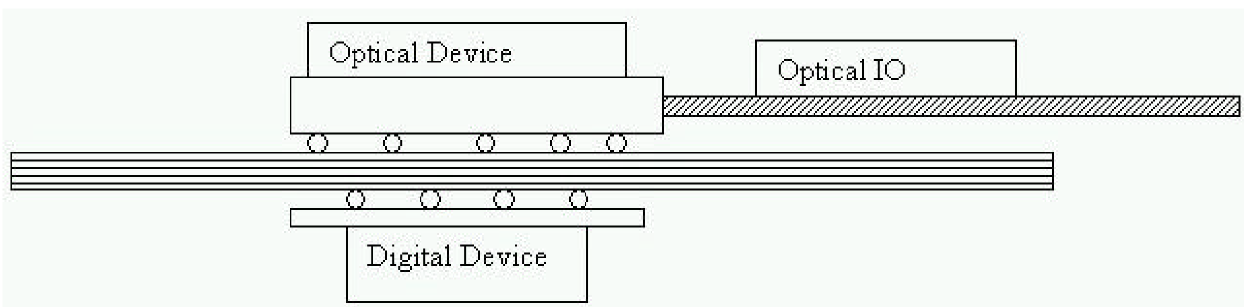

Figure 1 – Optical and digital Device Mounting

Table 1 - Embedded Passive Integration for PCB 1

Passive Element	Space Consideration	Cost Consideration	Technology Difficulty
Embedded Resistor	Embedded resistor would be well configured between active layers. Good	Several existing technologies can produce embedded resistors of varying tolerance. Low cost impact.	Small
Embedded Planar Capacitor	This plane capacitor would provide decoupling and save space. Good	Several methods of providing capacitive layers are available. Low cost impact.	Small
Embedded Discrete Capacitor	Very low values of capacitance can be produced in this manner. Poor	Very little technology available for this approach. High cost to effect impact.	Large
Embedded L elements	These elements are not a well defined requirement at this time. Marginal	These elements can be produced on power planes but are not generally applied in this fashion. High cost to effect ratio.	Moderate

Interposer Digital System

The interposer model is based on the requirement for reducing surface space and communication time between elements. The technology and limitations are not significantly different from the current systems deployed.

Digital Optical Device On Board

The primary change in this evolution of technology is the incorporation of the optical and digital sections in a chip and the inclusion of transmission elements in the PCB as can be seen in Figures 2 and 3. These will be correspondent to additional changes in the PCB process methods to incorporate these developments. It is believed that mirrors or lenses may be used to direct the transmitted light in this model, although the bends may be gradual to articulate the channels at escape resistant angles. All versions of this technique present a very difficult manufacturing scenario to the fabricator.

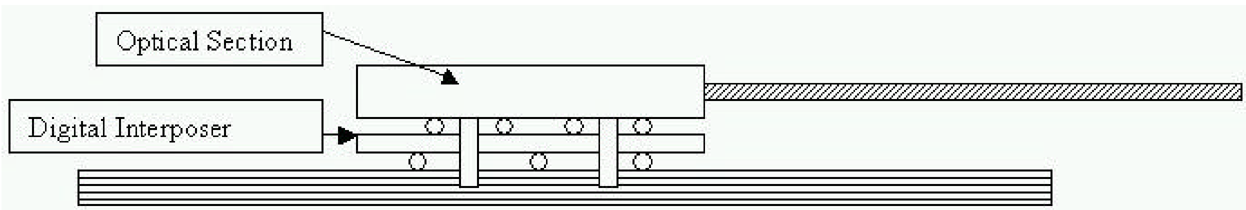

Figure 2 –Reductinof Surface Spare Usage Through the Inter-poser Model

Table 2 - Embedded Passive Integration for PCB 2

Passive Element	Space Consideration	Cost Consideration	Technology Difficulty
Embedded Resistor	Embedded resistor could be configured between active layers. However surface may be available. Marginal	Several existing technologies can produce embedded resistors of varying tolerance. Low cost impact.	Small
Embedded Planar Capacitor	This planar capacitor would provide decoupling and save space. Good	Several methods of providing capacitive layers are available. Low cost impact.	Small
Embedded Discrete Capacitor	Very low values of capacitance can be produced in this manner. A surface discrete would be preferable. Poor	Very little technology available for this approach. High cost to effect impact.	Large
Embedded L elements	These elements are not a well defined requirement at this time, but may warrant review. Marginal	These elements can be produced on power planes but are not generally applied in this fashion. High cost to effect ratio.	Moderate

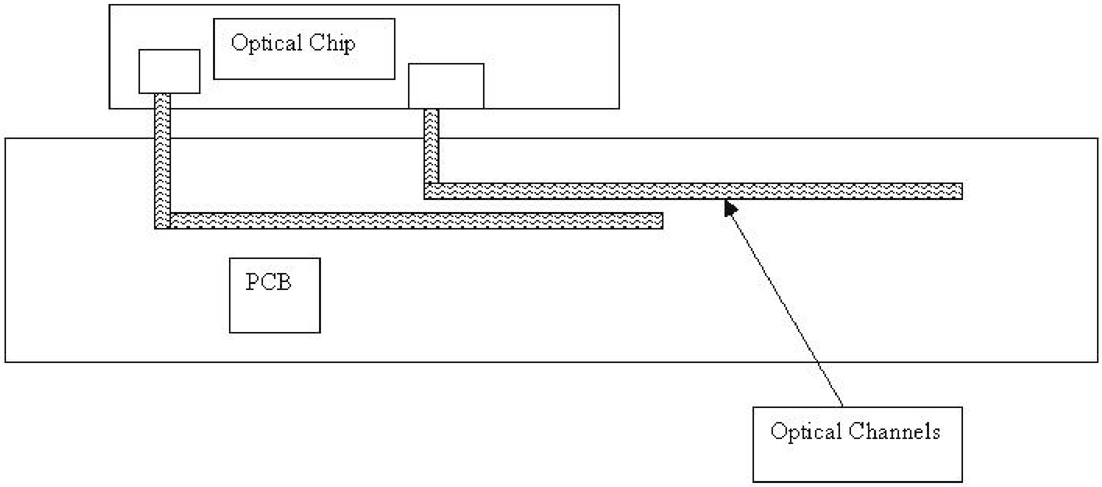

Figure 3 – Inclusion of Transmission Elements in a PCB

Table 3 - Embedded Passive Integration for PCB 3

Passive Element	Space Consideration	Cost Consideration	Technology Difficulty
Embedded Resistor	Embedded resistor would be well configured between active layers. Good	Several existing technologies can produce embedded resistors of varying tolerance. Low cost impact.	Small
Embedded Planar Capacitor	This planar capacitor would provide decoupling and save space. Good	Several methods of providing capacitive layers are available. Low cost impact.	Small
Embedded Discrete Capacitor	Very low values of capacitance can be produced in this manner. Poor	Very little technology available for this approach. High cost to effect impact.	Large
Embedded L elements	These elements are not a well defined requirement at this time. Marginal	These elements can be produced on power planes but are not generally applied in this fashion. High cost to effect ratio.	Moderate

Board Containing Embedded Optical Elements

While specifics are technology dependent the basic outline is shown in Figure 4.

It is assumed in the above design that the digital signals must be appropriately modified to be sent to the emissive element. This active device function may be eventually carried out on the transmission layer, prompting the need for more specific embedded elements, such as discrete capacitors. A clear advantage for the use of planar capacitance is seen in the construction of this model. The power planes should be capacitively coupled through one of the existing techniques. The need for internal resistor elements is increased by the probability of inner-plane active element operation. At this time the need for in-plane inductive devices is not well documented but should be considered.

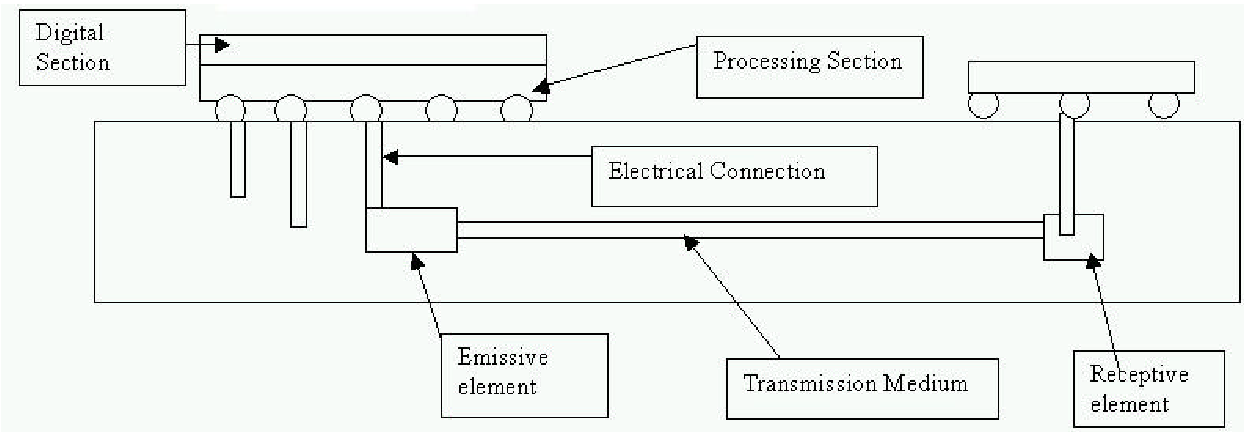

Figure 4 –OE Boards Utilizing Embedded Optics

Table 4 - Embedded Passive Integration for PCB 4

Passive Element	Space Consideration	Cost Consideration	Technology Difficulty
Embedded Resistor	Embedded resistor could be necessary between active layers. Excellent	Several existing technologies can produce embedded resistors of varying tolerance. Low cost impact.	Small
Embedded Planar Capacitor	This planar capacitor would provide needed decoupling and save space. Excellent	Several methods of providing capacitive layers are available. Low cost impact.	Small
Embedded Discrete Capacitor	Very low values of capacitance can be produced in this manner. These may be of use. Marginal	Very little technology available for this approach. High cost to effect impact.	Large
Embedded L elements	These elements are not a well defined requirement at this time. Marginal	These elements can be produced on power planes but are not generally applied in this fashion. High cost to effect ratio.	Moderate

Summary

In Summary, the purpose of this discussion is not to choose the form of the optical PCB that may be most responsive to the designer’s needs, time and technology will provide the answer to that conundrum. The goal of this discussion is to prompt the planning of how we may effectively use embedded elements in our optical design strategy and which are most appropriate for current designs. Of course, I have not included structure X. (Structure X is the “better idea” that we have collectively not thought of yet, or perhaps only I have missed it.) This structure will likely have need for preplanning of embedded elements, both passive and active, and should be planned as an integral part of the design.

The passive element toolbox is not as developed as many assume. Simple technologies such as polymer resistors, discrete capacitors, and other elements have proven difficult and expensive to incorporate in the PCB structure. The above recommendations stress utilizing proven and manufacturable embedded technology to minimize the risk when developing new designs including optical elements.