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MITIGATING THE GLASS-WEAVE EFFECT INSIDE A BGA

Yongchao Ji

Greg Fu

Siyuan Yang

Jun Liu

MengJie Hu

See next page for additional authors

Inventor(s)

Yongchao Ji, Greg Fu, Siyuan Yang, Jun Liu, MengJie Hu, and Maofei Yu

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ABSTRACT

For a printed circuit board (PCB) that includes many high-speed differential pairs may be routed the signal integrity (SI) performance of the pairs is to be carefully considered. One factor that may lead to a poorer SI performance, on the PCB itself and within a ball grid array (BGA) that is mounted on the PCB, is the glass-weave effect. To mitigate the impact of the glass-weave effect inside of a BGA, techniques are presented herein that support rotating the BGA by a free angle. With such a BGA rotation, a pair's traces will be rotated by the same angle and, consequently, the glass-weave effect on those traces can be mitigated.

DETAILED DESCRIPTION

When designing a PCB on which many high speed differential pairs may be routed the signal integrity (SI) performance of the pairs (comprising, for example, crosstalk, insertion loss, in-pair skew, etc.) is always a significant concern that involves careful consideration. One factor that may lead to a poorer SI performance is the glass-weave effect.

A PCB is made out of a glass fiber weave and a resin in which the resin fills in the grids in the fiber weave. When a differential pair is routed over such a surface, it may happen that a trace 'P' and a trace 'N' of the pair travel over the different structures of the weave. For example, one trace may travel on the fibers of a weave while the other trace may travel on the grids of a weave, as depicted in Figure 1, below.

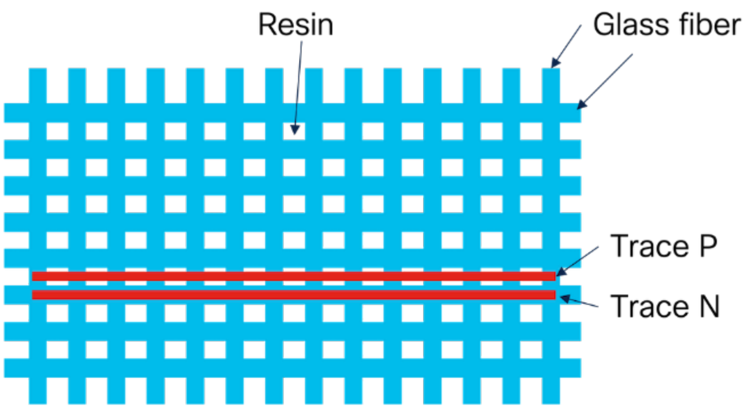

Figure 1: Exemplary Traces

Since the dielectric constant (Dk) of the glass fiber and the resin is different, a signal on the P trace and a signal on the N trace (as depicted in Figure 1, above) can have a different propagation velocity and, therefore, a different propagation time for arriving at a destination. Such a value represents a differential pair's skew and it often referred to as the glass-weave effect.

The conventional technique for mitigating the impact of the glass-weave effect involves placing a pair's traces in such a way that they are not parallel to the glass weave fiber. That is, a rotation angle may be established between the pair's traces and the weave fiber, as shown in Figure 2, below.

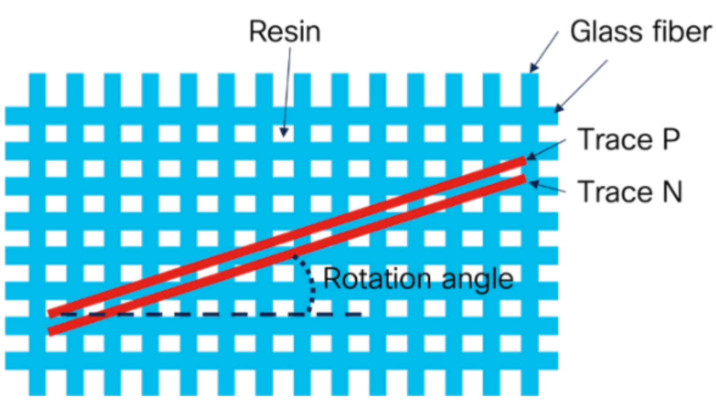

Figure 2: Exemplary Traces with Rotation Angle

As depicted in Figure 2, above, the weave structures that lie beneath a trace P and a trace N are almost the same, thus reducing the pair's skew.

Currently, there are two conventional techniques through which a rotation angle may be introduced between a pair's traces and a weave fiber. A first conventional technique for introducing a rotation angle involves having a PCB vendor rotate the design image (i.e., a board) in the working panel of manufacture. Figure 3, below, depicts elements of this approach.

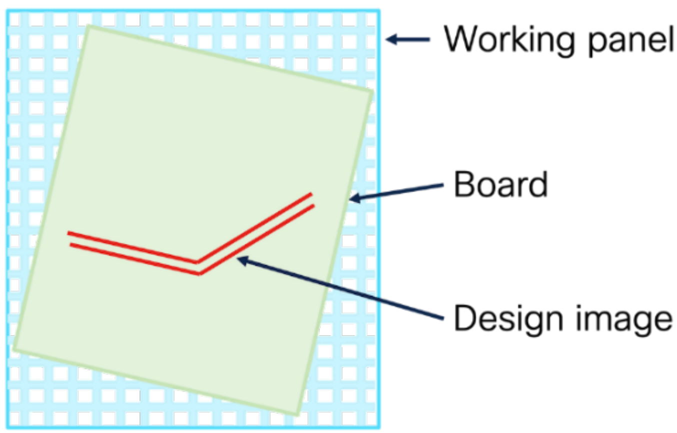

Figure 3: Example of First Approach

A downside of this first conventional approach is that the cost of a PCB is sometimes higher, because the rotated board sometimes requires a larger working panel, and it leads to a lower utilization of the working panel.

A second conventional technique for introducing a rotation angle involves keeping a board un-rotated in the working panel but routing the differential pairs in free angles on the board. Figure 4, below, depicts elements of this approach.

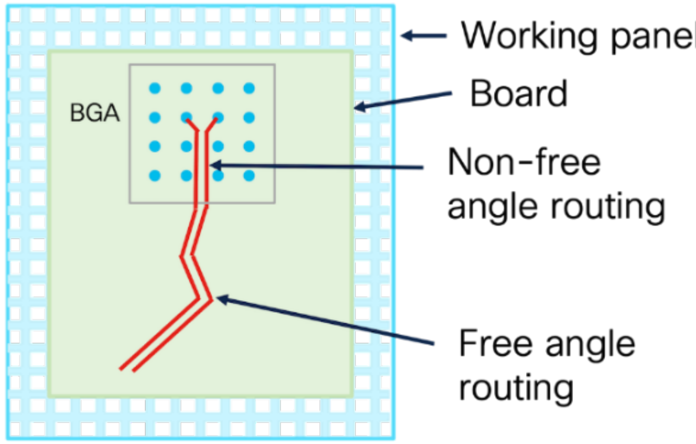

Figure 4: Example of Second Approach

In comparison to the first conventional approach (involving rotating a board), an advantage of the second conventional approach is a lower PCB cost. However, disadvantages or problems with the second approach may be that the high-speed pairs that are inside the BGA are still routed horizontally or vertically because the BGA is placed horizontally or vertically. Thus, the glass-weave effect is still present in the pairs' traces inside of the BGA. The larger the BGA is, the longer the pair's traces are, and, as a result, the more severe will be the glass-weave effect.

To mitigate the impact of the glass-weave effect inside of a BGA, techniques are presented herein that support rotating the BGA by a free angle. With such a BGA rotation, a pair's traces can be rotated by the same angle and, consequently, the glass-weave effect on those traces can be mitigated.

While rotating a BGA by 45 degrees is sometimes adopted, such an approach is primarily used to provide a smooth BGA fanout in order to make Serializer/Deserializer (SerDes) routing shorter. In contrast, the techniques presented herein call for rotating a BGA only slightly. According to the presented techniques, such a rotation angle may be between 5 degrees and 20 degrees and may be determined based on a SI engineer's requirements and the available space on a PCB.

To improve the accuracy of an assembly and to reduce risks in a surface mount technology (SMT) assembly process, a rotation angle (as described above) should be an integer multiple of the rotation motor's step of the SMT machine's picker. For example, when a rotation motor's step is 0.2 degrees, the BGA rotation angle should be an integer multiple of 0.2 degrees. Accordingly, a rotation angle of 5.5 degrees would not be a good choice. In contrast, a rotation angle of 5.0, 5.4, or 5.6 may be a better choice.

Figure 5, below, depicts elements of an exemplary BGA rotation according to the techniques presented herein and reflective of the above discussion.

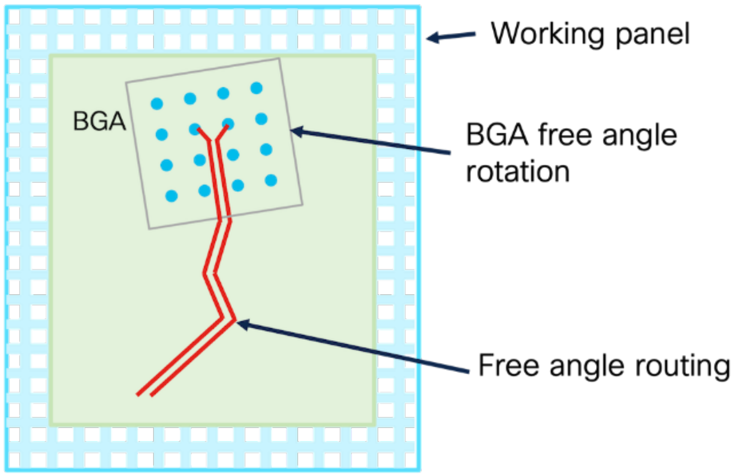

Figure 5: Exemplary BGA Rotation

In summary, to mitigate the impact of the glass-weave effect inside of a BGA, techniques have been presented herein that support rotating the BGA by a free angle. With such a BGA rotation, a pair's traces will be rotated by the same angle and, consequently, the glass-weave effect on those traces will be mitigated. According to aspects of the presented techniques, such a rotation angle may be between 5 and 20 degrees and should, to improve assembly accuracy and reduce risks in a SMT assembly process, be an integer multiple of the rotation motor's step of the SMT machine's picker. For example, when a rotation motor's step is 0.2 degrees, the BGA rotation angle should be an integer multiple of 0.2 such as, for example, 5.0, 5.4, 5.6, etc.