

## **Design Guide Lines for STABLCOR®**

### **The Printed Wiring Board and Substrate Technology**



Prepared by: Kris Vasoya

Inventor of the STABLCOR Technology

Rev-06-0106

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# ThermalWorks

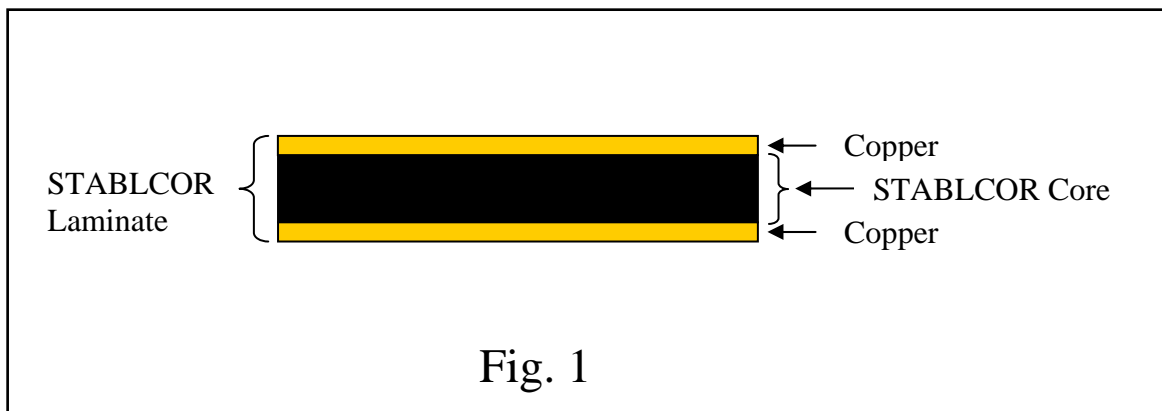
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## 1. Introduction

ThermalWorks is a leading edge research company and is glad to announce STABLCOR<sup>®</sup> technology. STABLCOR<sup>®</sup> is a patented printed wiring board technology and solely own by ThermalWorks. This Technology brings the following benefits to the printed wiring boards. (1) It increases thermal conductivity of PCB, (2) it can tailor co-efficient of thermal expansion (CTE) of PCB, (3) it increases stiffness/rigidity of PCB substantially which helps to prevent Warp and (4) all above three benefits at very minimal weight premium (approx. less than 3%).

## 2. Material

STABLCOR<sup>®</sup> material is available only in fully cured laminate form as shown in Fig.1. STABLCOR<sup>®</sup> material is not a dielectric material. So, it will be used as an electrically conductive layer like plane layers. It could be used as a ground or power or split plane layers. Most preferably it will be used as a ground layer. Fig.1 shows detailed structure of the STABLCOR<sup>®</sup> laminate material.



STABLCOR<sup>®</sup> Laminate will replace ground or power Copper layer in PCB design (not all plane layers but, only selected plane copper layers will be replaced with STABLCOR<sup>®</sup> laminate. See Appendix-A for more detail.).

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## 3. Material Selector Guide

STABLCOR<sup>®</sup> material is available in High Temp. Epoxy (170°C) as well as in Ultra High Temp. Epoxy (210°C). Typical copper thicknesses are ½oz or 1oz on both sides. Different copper thicknesses are available upon request.

Table: 1 STABLCOR material

RAW MATERIAL	THERMAL CONDUCTIVITY (W/m*K)	CTE (ppm/C)	DENSITY (g/cm3)	TENSILE MODULUS (msi)	Typical Core Thicknesses
ST325*	325.0	-1.15	2.20	114.0	0.008"
ST10*	8.0	-0.60	1.76	33.5	0.006", 0.009"

\*A STABLCOR value represents data of raw fiber.

- STABLCOR<sup>®</sup> material is available in High temp. Epoxy and Ultra High temp. Epoxy.
- High Temp. Epoxy STABLCOR<sup>®</sup> Laminate has a glass transition temp. of Tg=170°C. P/N:EP387
- Ultra High temp. Epoxy STABLCOR<sup>®</sup> Laminate has a glass transition temp. Of Tg=210°C. P/N:EP450
- Typical STABLCOR<sup>®</sup> thicknesses are described in Table:1. Thicker material can be available upon request.
- Copper Thickness must be the same on both sides of the STABLCOR<sup>®</sup> core.
- ST325 is the *"BEST BANG FOR THE BUCK"*.

## 4. General Design rules

- I. STABLCOR<sup>®</sup> layers must be symmetrical in the PCB layer stack-up. See Fig. 2 below.

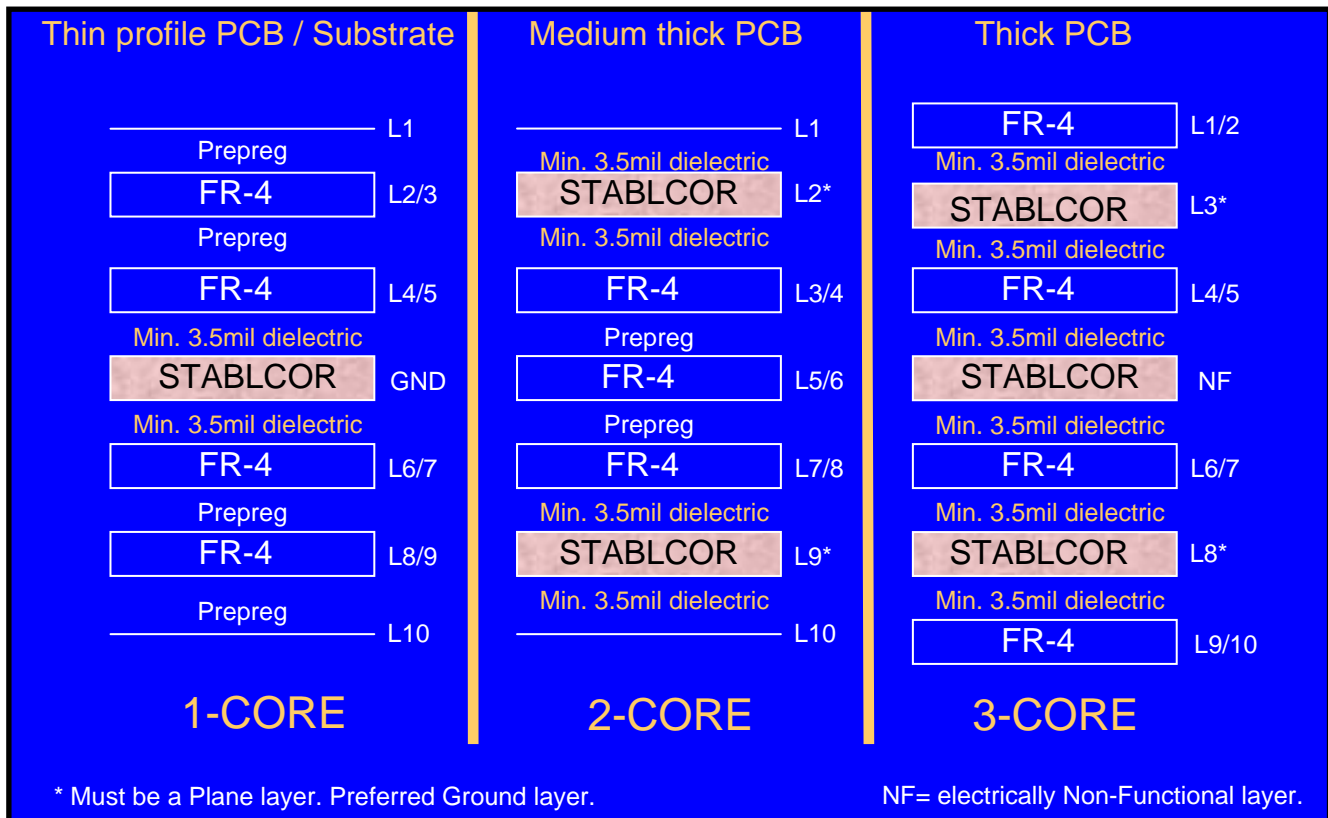
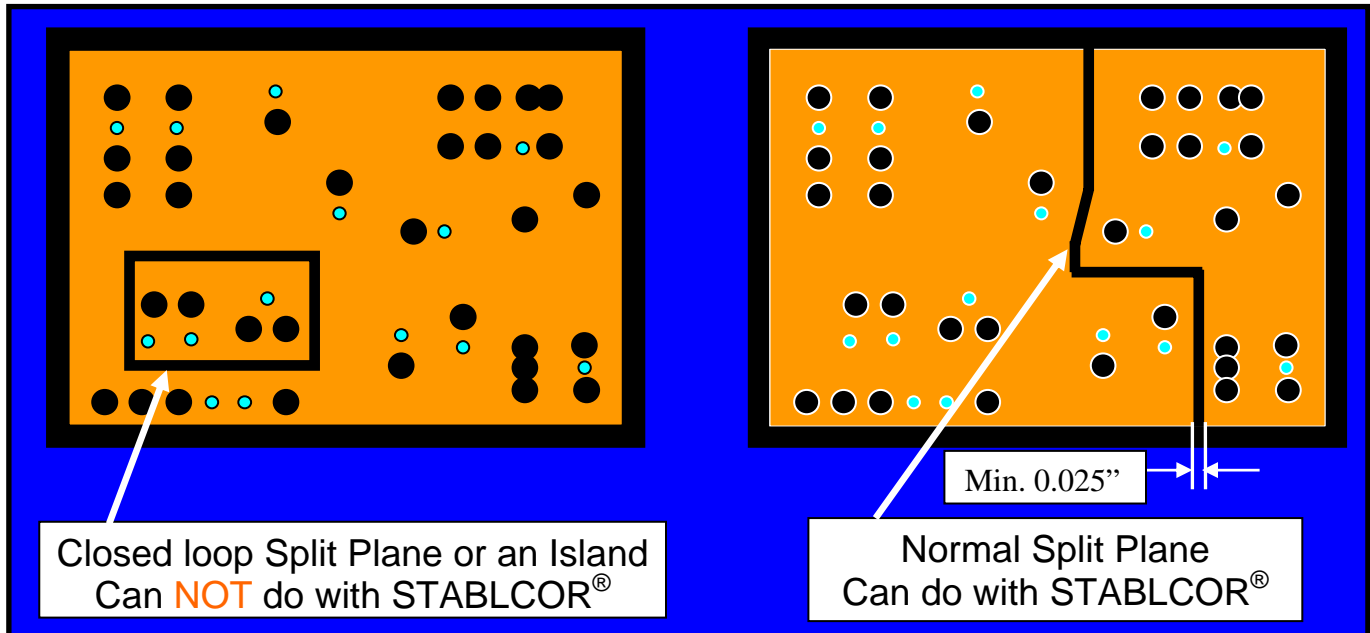


Fig. 2

- II. STABLCOR<sup>®</sup> material can be used as a GROUND or POWER layer.
- III. It is recommended to use STABLCOR<sup>®</sup> as a Ground layer. STABLCOR<sup>®</sup> Core material will be exposed at the edges of the PCB.
- IV. STABLCOR<sup>®</sup> material can be used as a power layer if the PCB is not mounted to a frame or chassis. i.e. free standing like Daughter cards, Memory modules etc. It is recommended to seal exposed edges.

V. STABLCOR<sup>®</sup> material also can be used as a split plane layer. See Fig. 3.

- Split Plane can not be a closed loop (i.e. Avoid an Island).
- Minimum gap between Split planes must be 0.025”.



Note: Split plane in STABLCOR is made using mechanical routing process but not chemical etching process

Fig. 3

## 5. Application Specific Design Guide Lines

### 5.1. THERMAL

Depending on the type of STABLCOR<sup>®</sup> material used; STABLCOR<sup>®</sup> PCBs will have good thermal conductivity. This will help in reducing or eliminating hot and cold spots on PCB. The STABLCOR<sup>®</sup> PCB acts as a heat sink or a heat spreader. Like any heat sink if the incoming volume of heat is greater than the heat dissipated, the heat sink will saturate. A similar phenomenon will happen with the STABLCOR<sup>®</sup> PCBs. In order to avoid PCB saturation you need to pull heat from the PCB. We recommend a few guidelines on how to create thermal paths between the PCB and the mounting frame or chassis. These are just few examples. You can modify any way you want to create thermal paths.

5.1.1. STABLCOR<sup>®</sup> as a GND layer: Connect the ground pins to the STABLCOR<sup>®</sup> Plane. Connect the STABLCOR<sup>®</sup> layer to a frame or chassis via [mounting screw or bolt](#). See Fig.4 below. This will create thermal paths from die to GND STABLCOR<sup>®</sup> layer to Screw to Chassis.

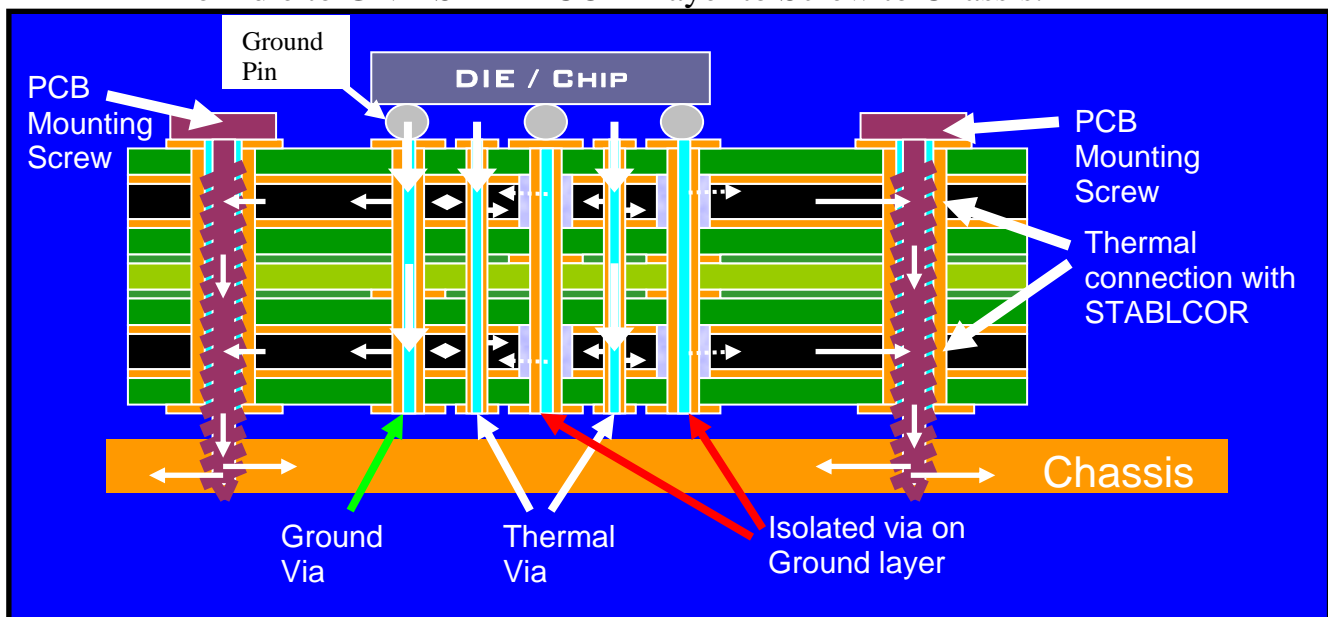


Fig. 4

You can also add thermal vias underneath the component as shown in Fig.4.

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5.1.2. STABLCOR<sup>®</sup> as a GND layer: Connect Ground pins to STABLCOR<sup>®</sup> Plane. Connect STABLCOR<sup>®</sup> layer using **Edge Plating** to a frame or chassis via **Wedge locks**. See Fig.5 below. This will create a thermal path from the die to the STABLCOR<sup>®</sup> GND layers to the plated edges of the PCB to wedge locks to a frame or chassis.

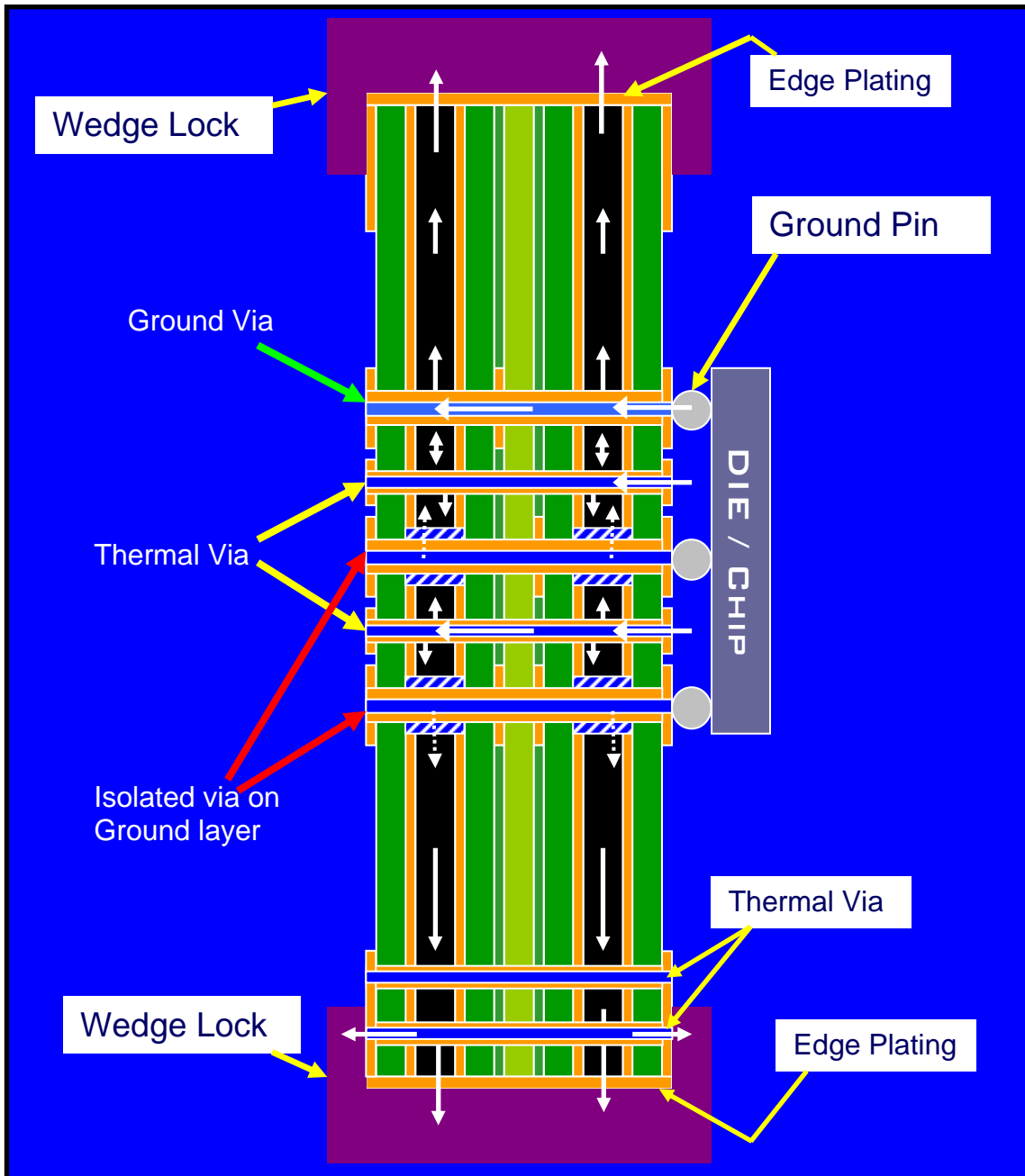


Fig. 5

## 5.2. CTE (Co-efficient of Thermal Expansion)

STABLCOR<sup>®</sup> material has a very low CTE. When it is used with other printed wiring board materials, the resulting composite PCB has very low CTE. You can tailor CTE of the finished PCB based on:

- 5.2.1. The ratio of the STABLCOR<sup>®</sup> material versus other materials in the PCB assembly; a higher ratio will give you a lower CTE.
- 5.2.2. The location of the STABLCOR<sup>®</sup> material in the layer stack-up. i.e. STABLCOR<sup>®</sup> material closer to the surface will lower surface CTE.
- 5.2.3. Complexity of design and via hole integrity passing through STABLCOR<sup>®</sup> layers.

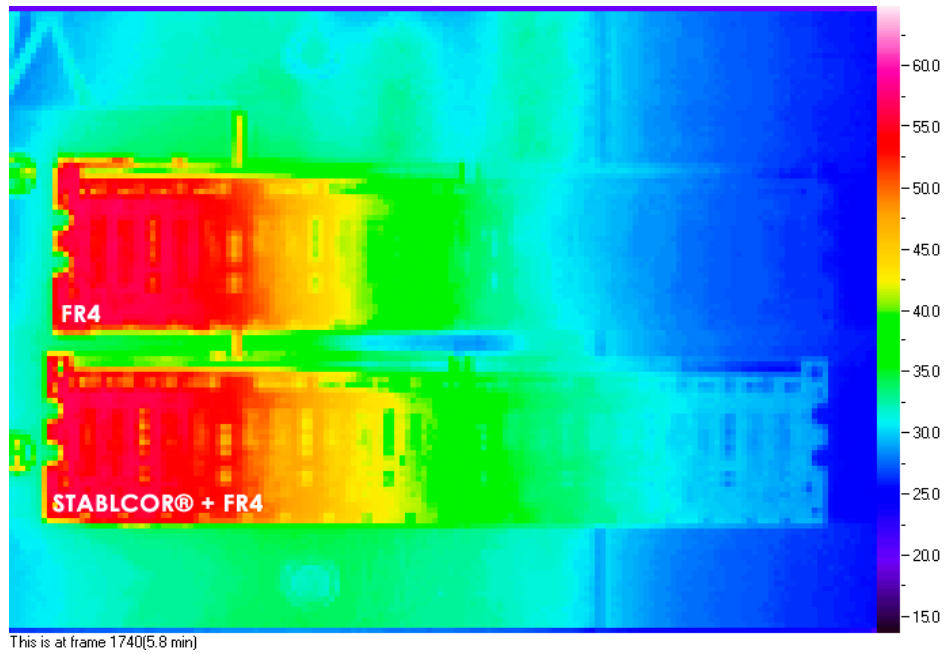
## 5.3. RIGIDITY / STIFFNESS

The STABLCOR<sup>®</sup> material is very rigid and has a very high tensile modulus. When it is used with other printed wiring board materials, the resulting composite PCB is very rigid and has a very high tensile modulus. Composite PCBs can be as high as 3 to 10 times more rigid than a normal PCB. This will help in reducing or eliminating mechanical reinforcements (metal) used today with typical PCBs, which will increase shock & vibration frequency. You can tailor the rigidity of the finished PCB based on:

- 5.3.1. The ratio of STABLCOR<sup>®</sup> material versus other materials in the PCB assembly, a higher ratio will give you a higher rigidity.
- 5.3.2. Complexity of design and via hole integrity passing through STABLCOR<sup>®</sup> layers.

## 5.4. ASSEMBLY PROFILE:

The STABLCOR<sup>®</sup> material is very thermally conductive. Thus, Printed circuit board or substrate manufactured using STABLCOR material will be thermally conductive compared to traditional FR4 or any other dielectric material PCB. Thermal conductivity of finished PCB depends on the grade, thickness and number of STABLCOR layers used in a stack-up.



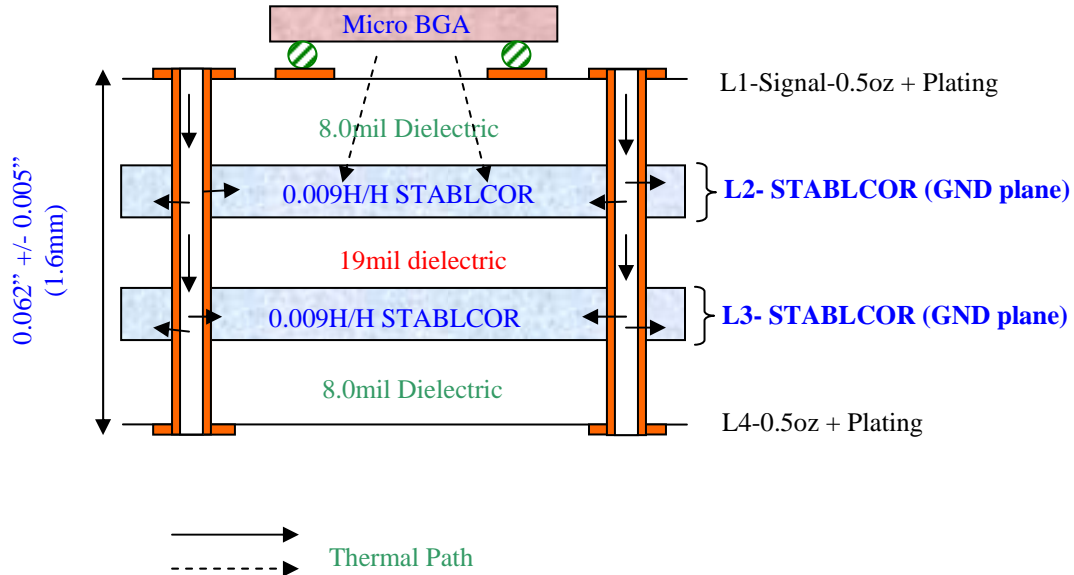
As seen in above Thermal Picture, STABLCOR<sup>®</sup> pcb is thermally conductive compare to FR4 pcb. We recommend our customer to profile STABLCOR pcb similar to metal core pcbs or any other thermally conductive pcbs.

## **Appendix: A**

# **EXAMPLES OF LAYER STACK-UP USING STABLCOR® MATERIAL**

# 4-Layer, 0.062" test board with STABLCOR

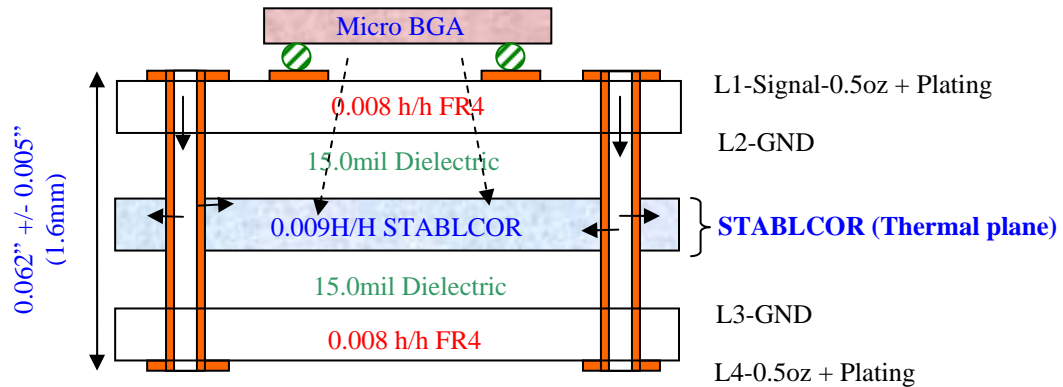
## \* Option # 1



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 4-Layer, 0.062" test board with STABLCOR

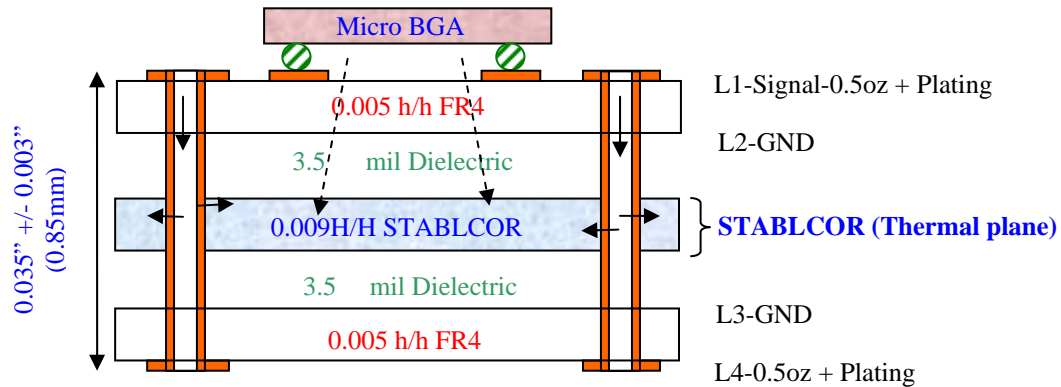
## \* Option # 2



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 4-Layer, 0.035" test board with STABLCOR

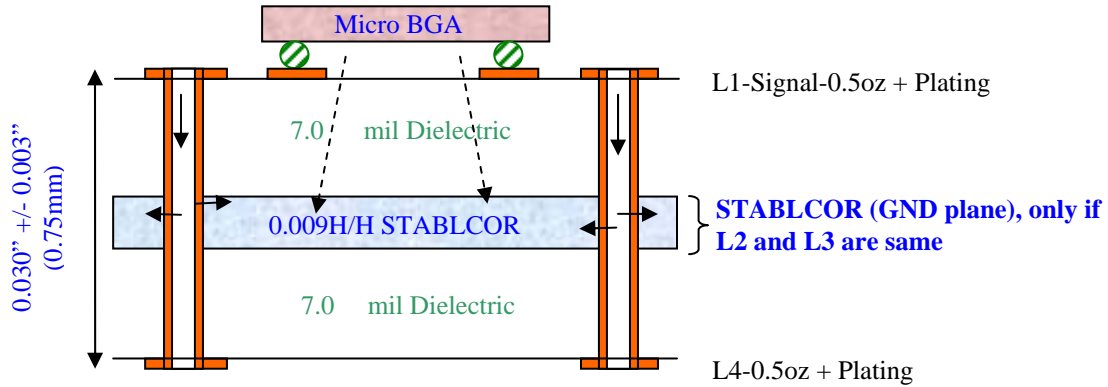
## \* Option # 3



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 4-Layer, 0.030" test board with STABLCOR

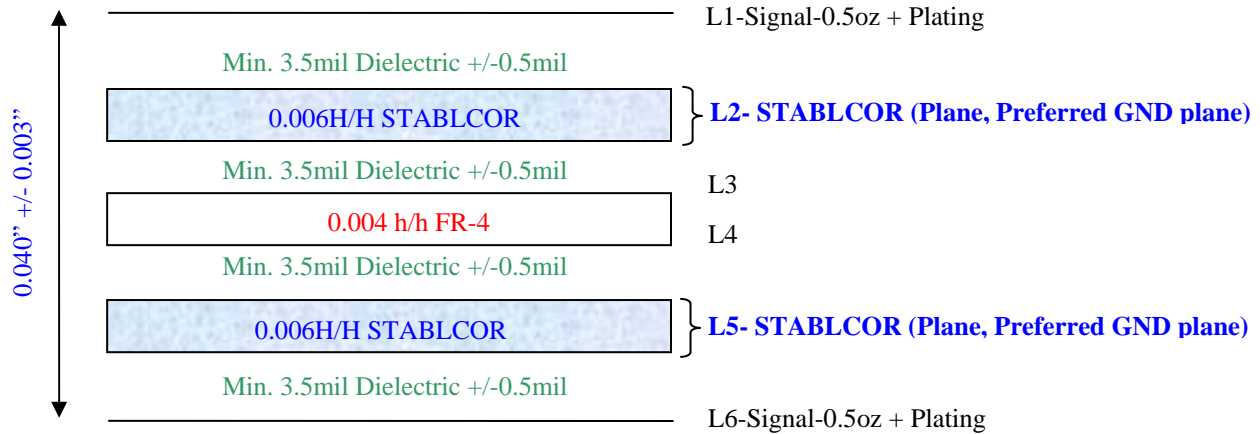
## \* Option # 4



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 6-Layer, 0.040" STABLCOR PCB Stack-up for SO-DIMM MEMORY Module

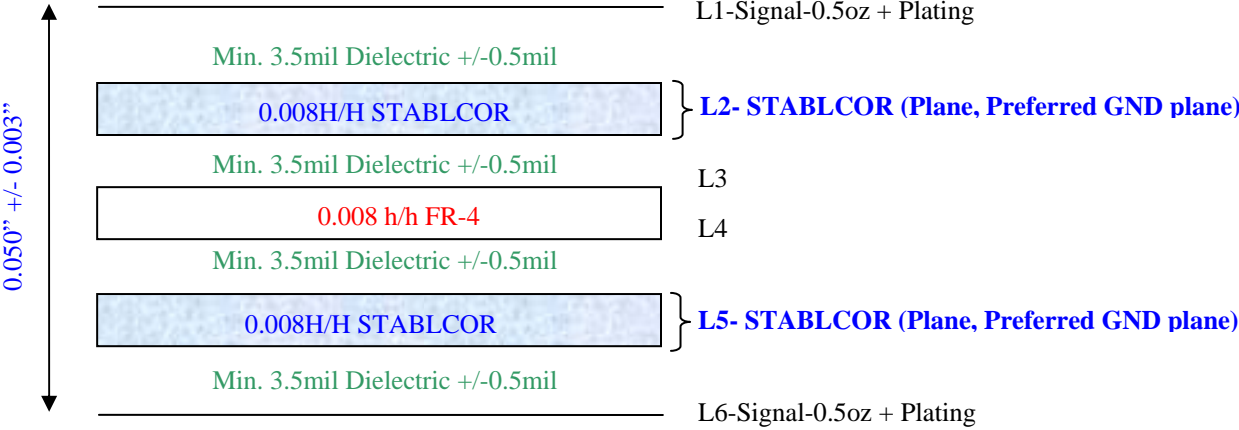
## \* Layer Stack-up:



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 6-Layer, 0.050" STABLCOR PCB Stack-up for MEMORY Module

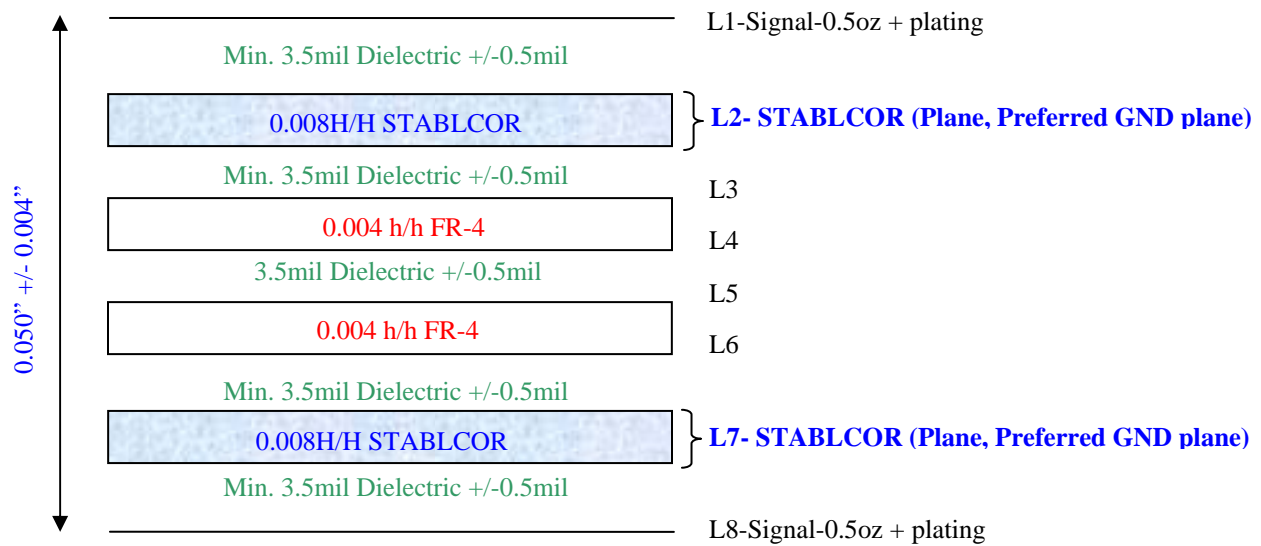
**\* Layer Stack-up:**



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 8-Layer,0.050" STABLCOR PCB Stack-up for MEMORY Module

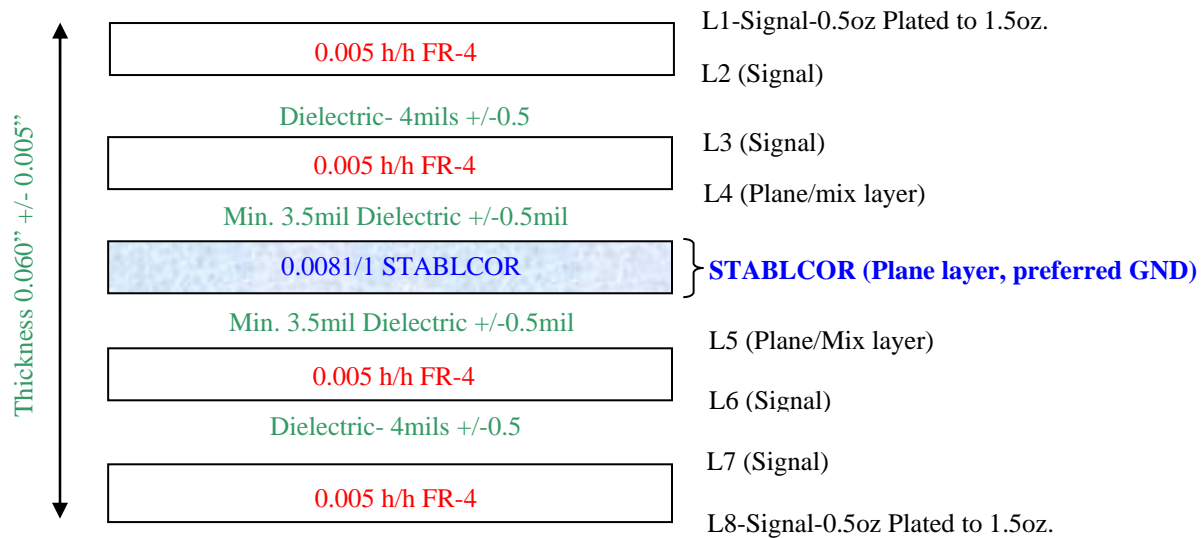
## \* Example # 1



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

## 8 Layer, 0.060" STABLCOR PCB Layer stack-up

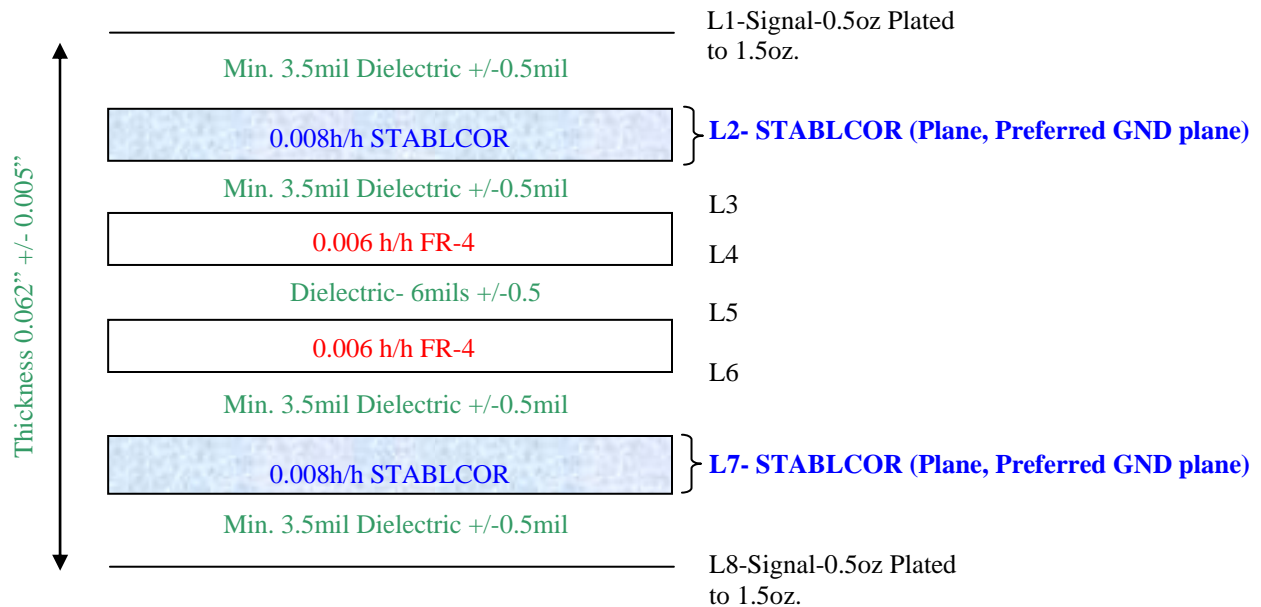
### \* Example # 2: One STABLCOR layer in center



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

## 8 Layer, 0.062" STABLCOR PCB Layer stack-up

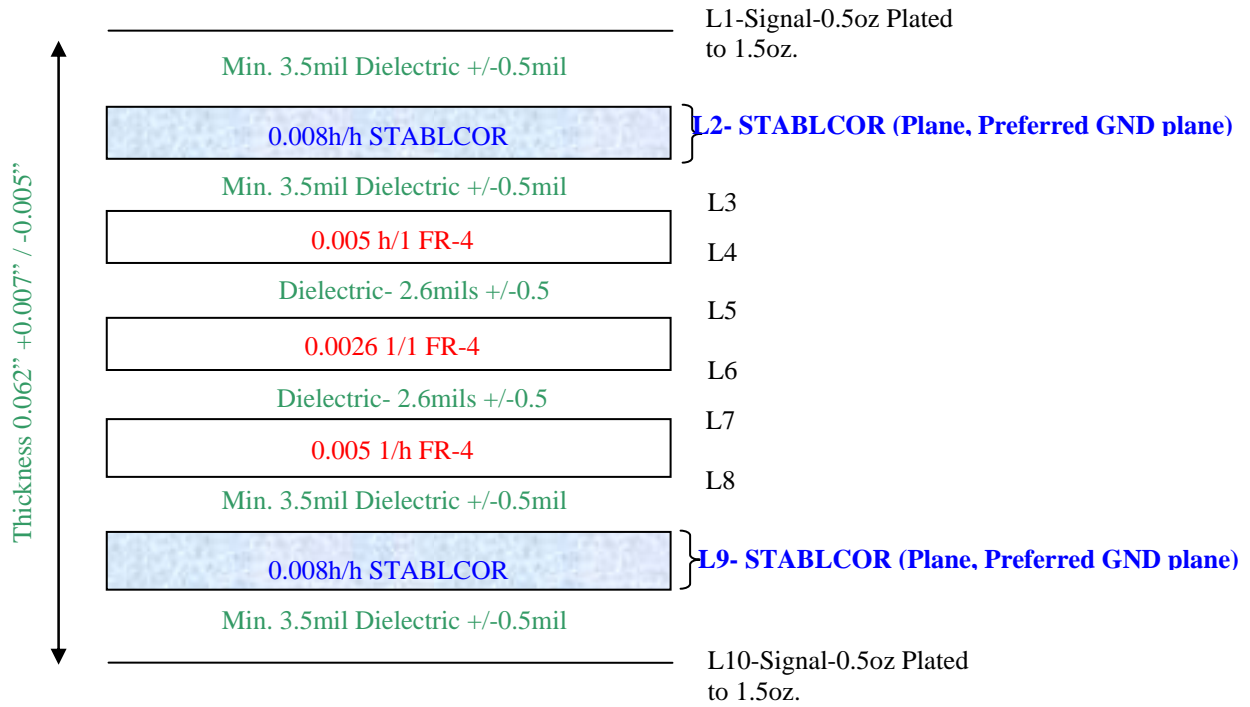
### \* Example # 3: STABLCOR at layer 2 and 7



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 10 Layer, 0.062” STABLCOR PCB Layer stack-up

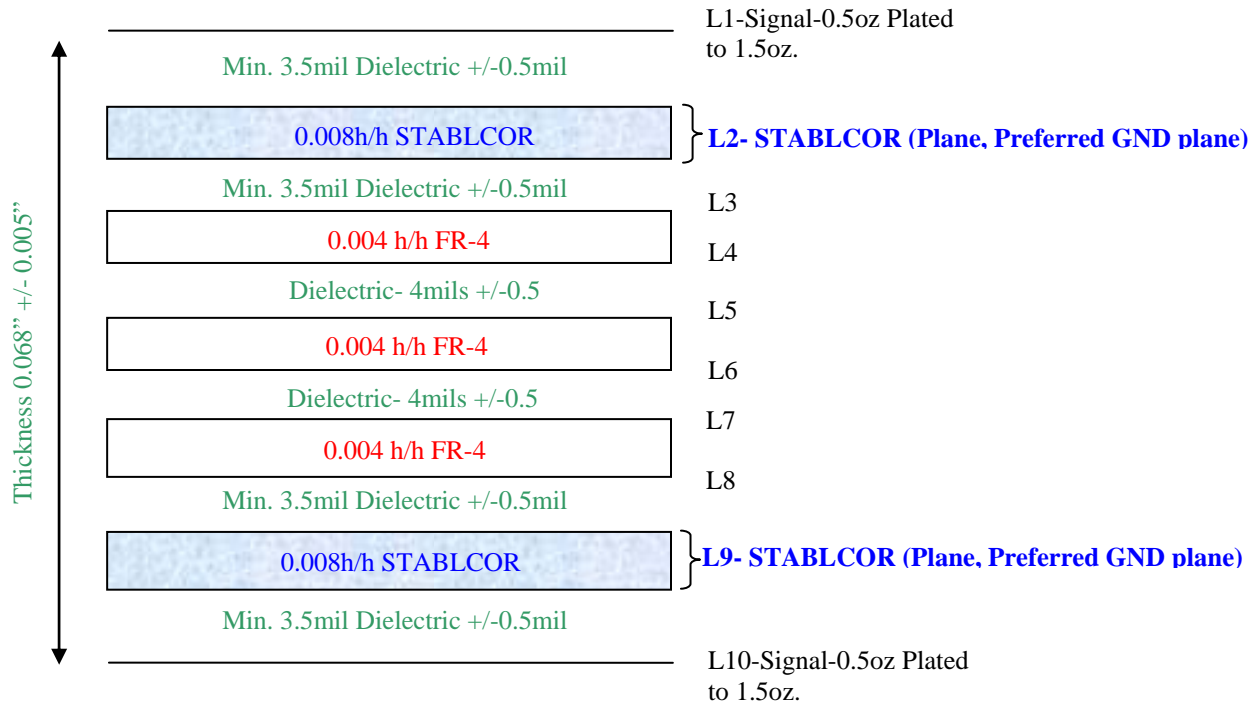
## \* Example # 1: Simple Stack-up



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 10 Layer, 0.070" STABLCOR PCB Layer stack-up

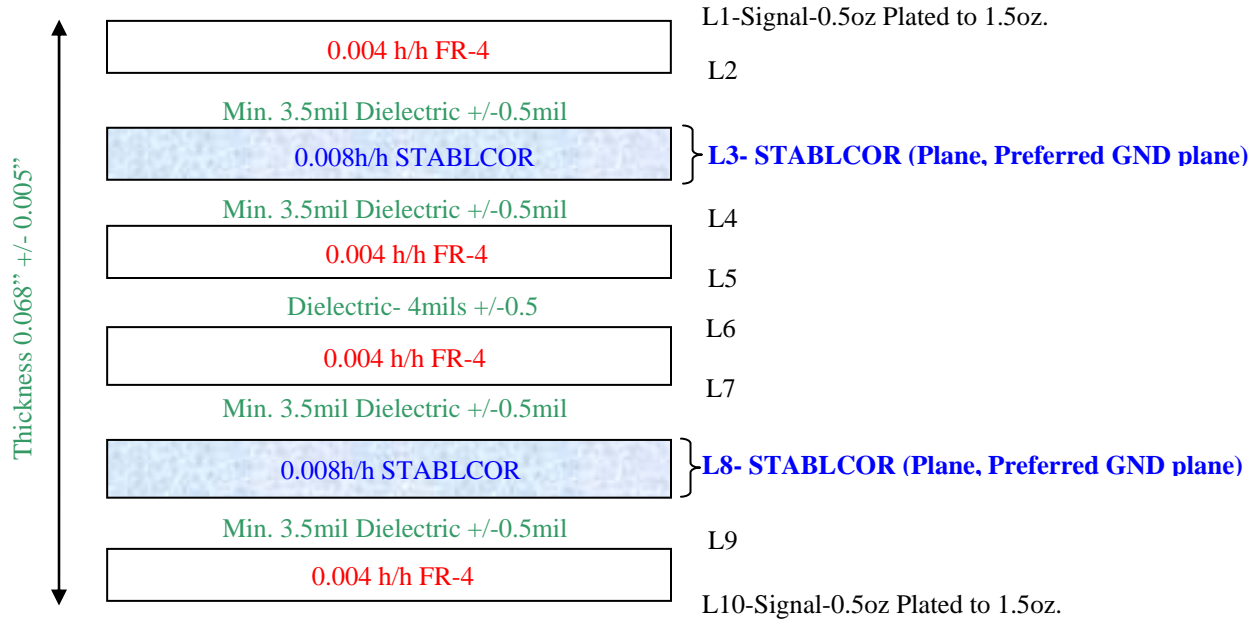
## \* Example # 2: STABLCOR at L2 and L9.



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 10 Layer, 0.070" STABLCOR PCB Layer stack-up

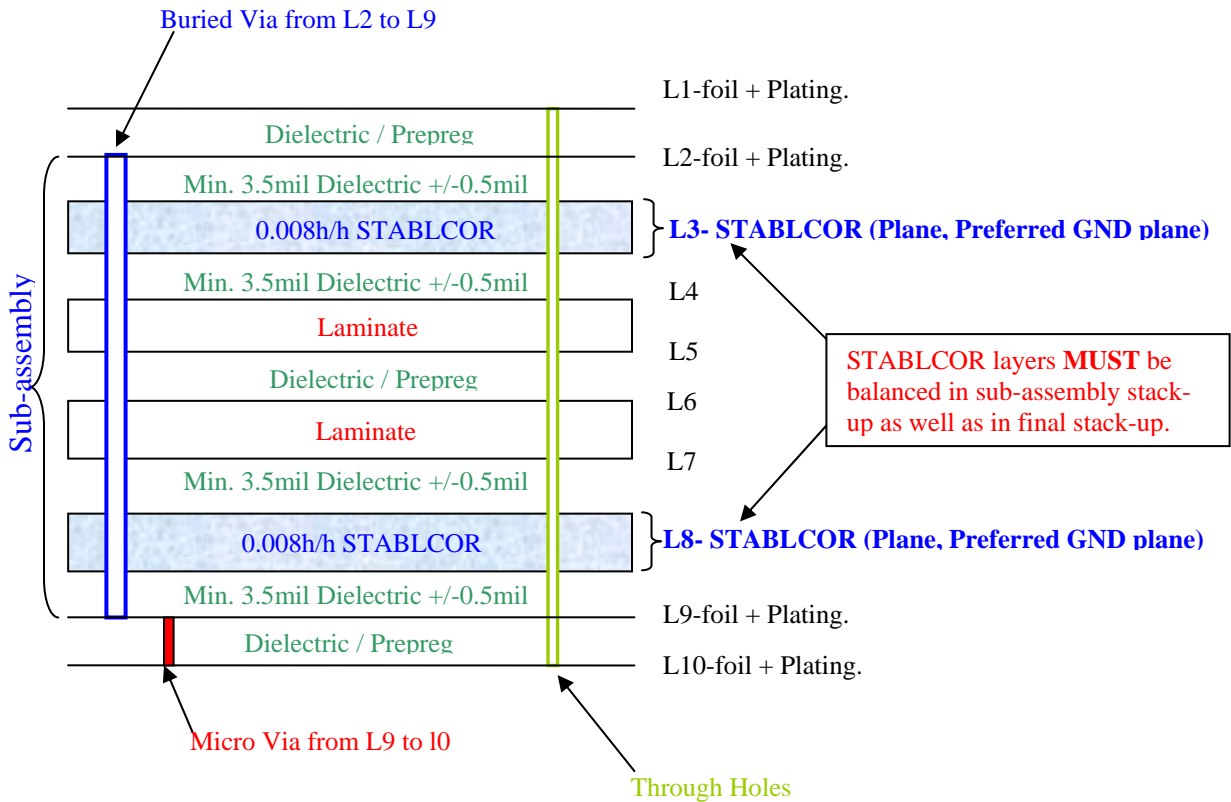
## \* Example # 3: STABLCOR at L3 and L8.



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 10 Layer, micro via & Buried via STABLCOR PCB Layer stack-up

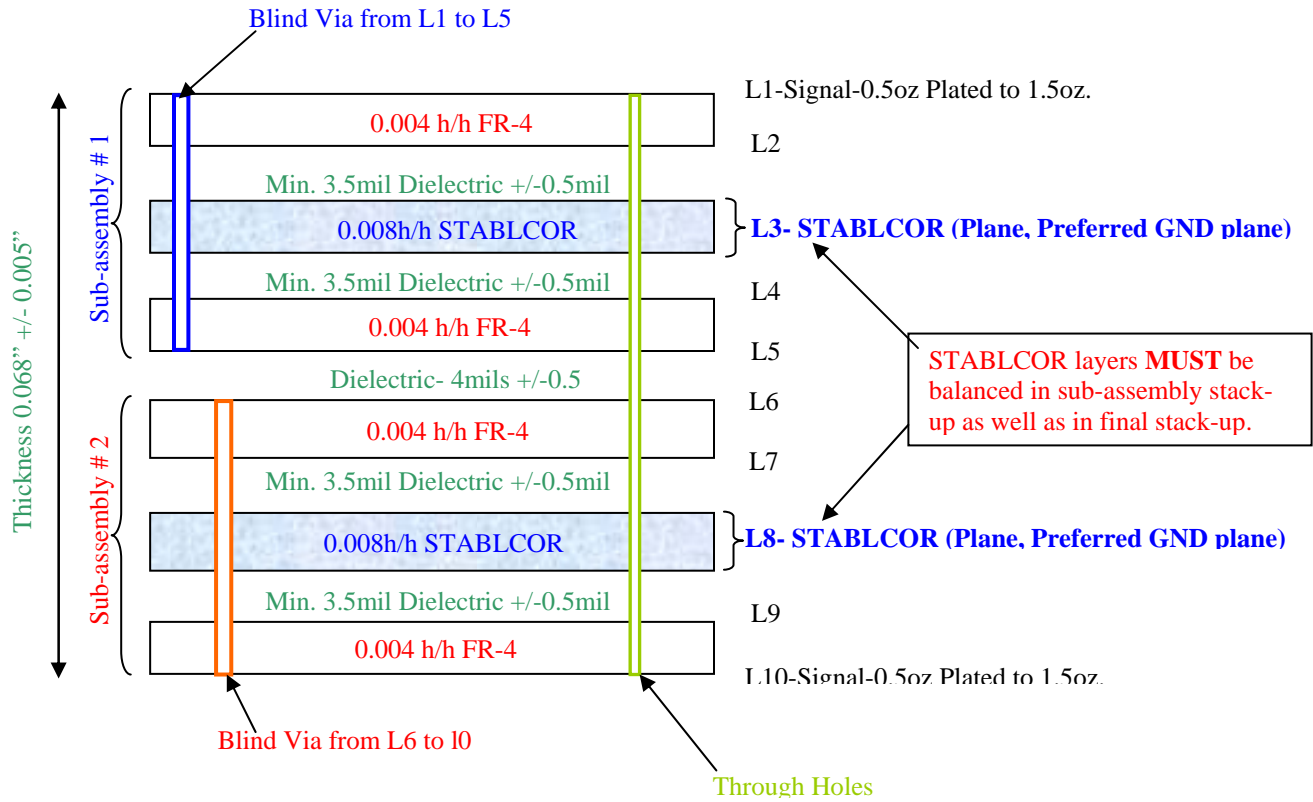
**\* Example # 4: STABLCOR at L3 and L8 with micro & Buried via Technology.**



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 10 Layer, Blind via, 0.070" STABLCOR PCB Layer stack-up

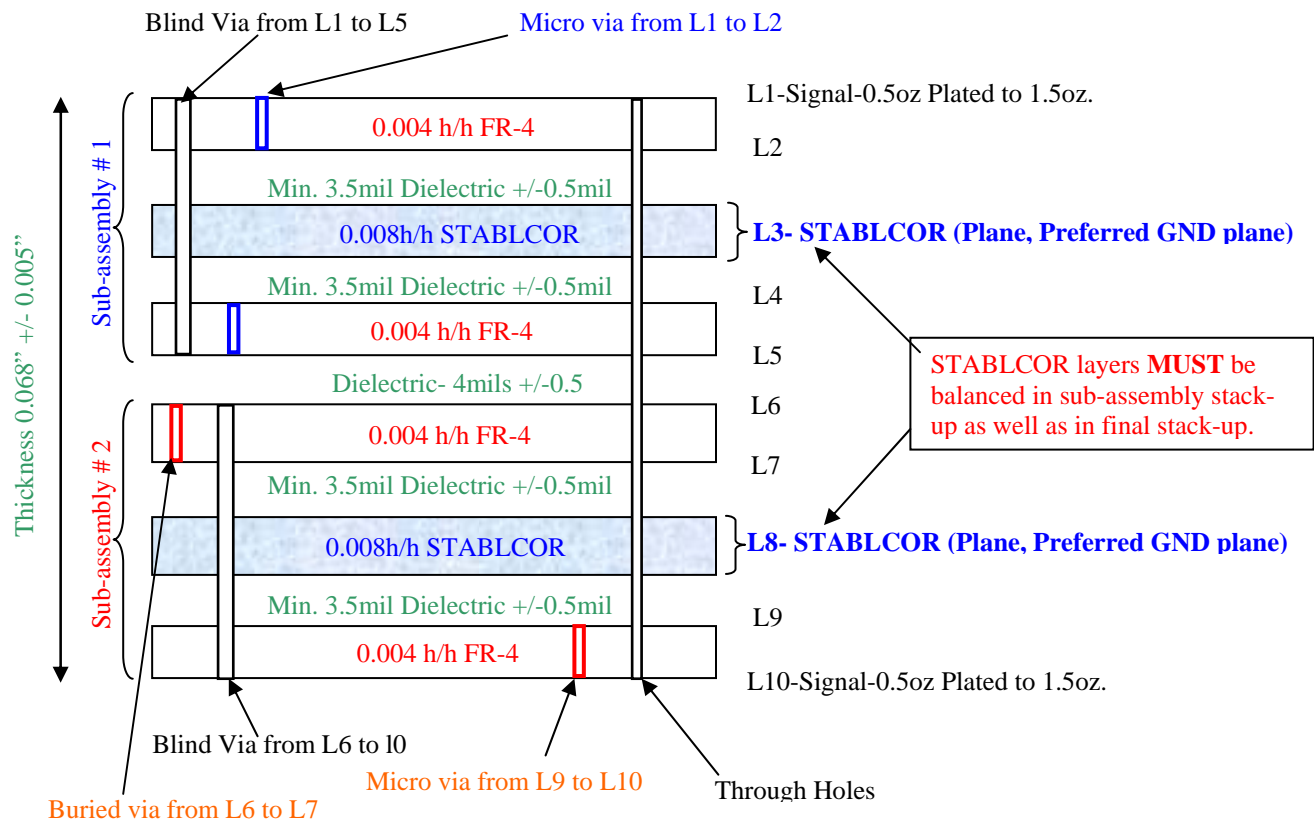
**\* Example # 5: STABLCOR at L3 and L8 with Blind via Technology.**



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 10 Layer, Blind & Buried via, Micro via, 0.070" STABLCOR PCB Layer stack-up

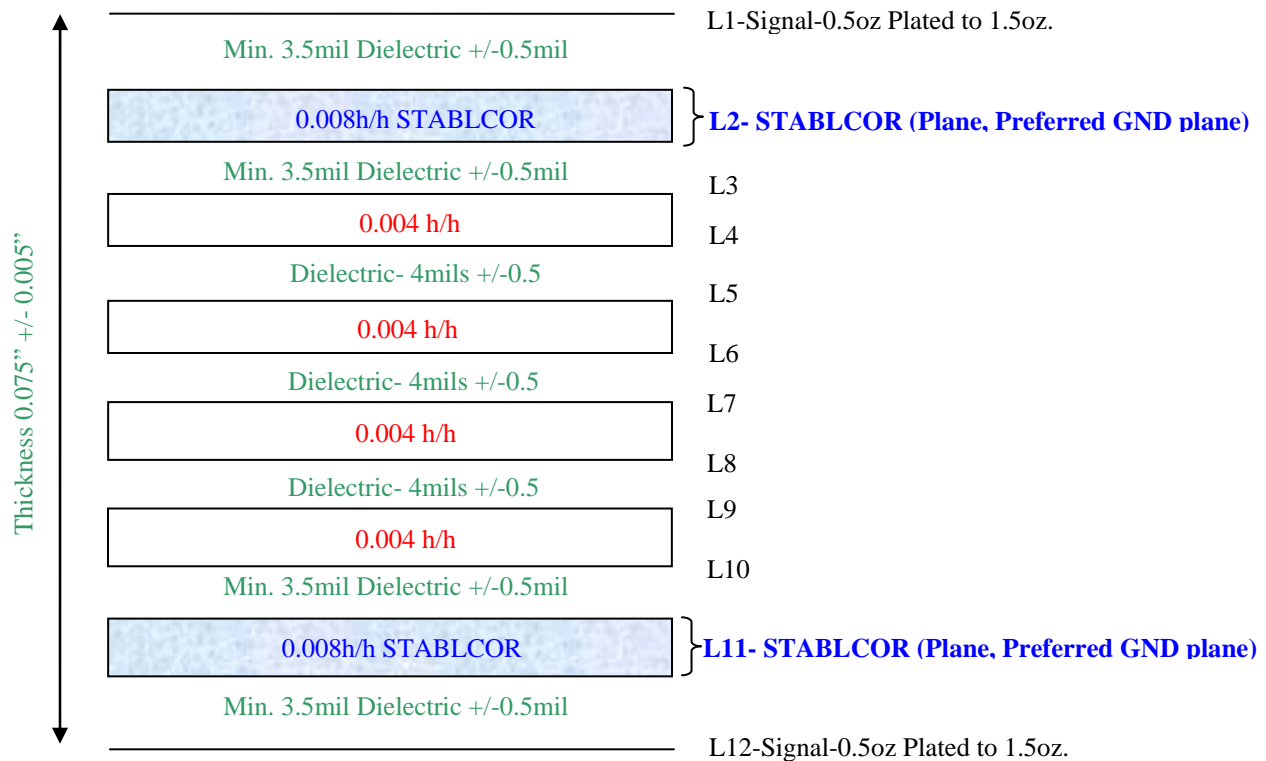
**\* Example # 6: STABLCOR at L3 and L8 with Blind, Buried and micro via Technology.**



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 12 Layer, 0.075” STABLCOR PCB Layer stack-up

## \* Example # 1: STABLCOR at L2 and L11.

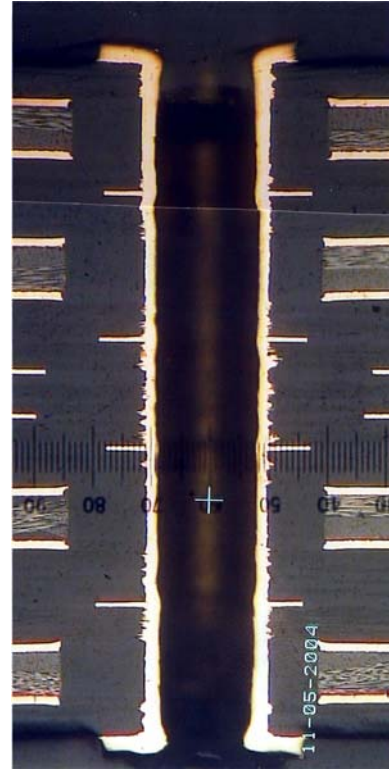


**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# Actual 12-Layer pcb, 0.125", SATBLCOR + Nelco-6 + Hitachi

## Example # 2

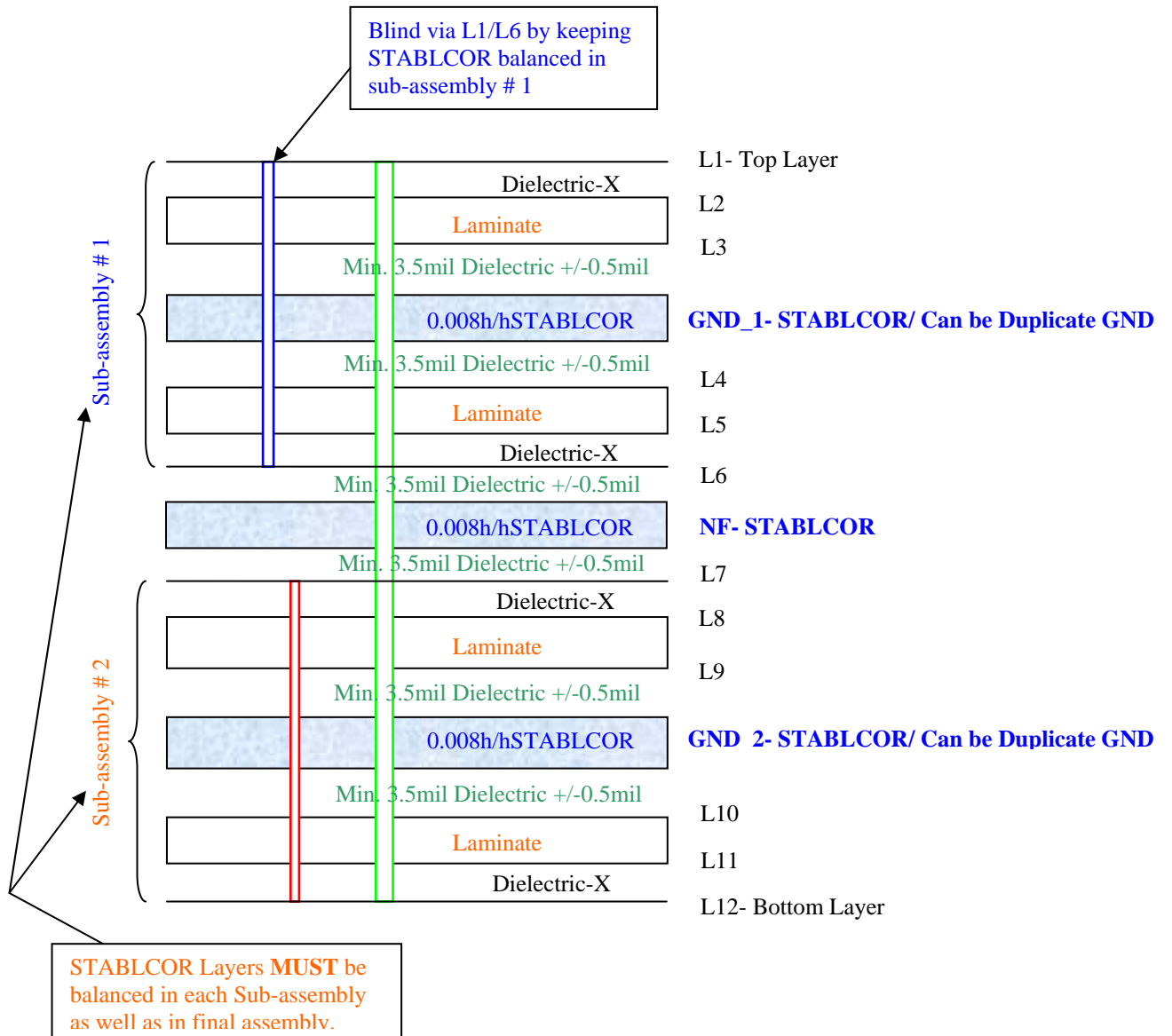
1ply 2313H, GIA_671N Hitachi	Signal
1ply 1080F, GIA_671N Hitachi fill preg	
<b>0.009H/H STABLCOR</b>	STABLCOR, GND
1ply 1080F Hitachi fill preg	
1ply 2313H Hitachi	
<b>0.005h/h Nelco-6</b>	Signal
1ply 106, GIA_671N Hitachi	Etch off
1ply 1080F Hitachi fill preg	
<b>0.009H/H STABLCOR</b>	STABLCOR, GND
1ply 1080F Hitachi fill preg	
1ply 2313H Hitachi	
<b>0.005h/h Nelco-6</b>	Signal
1ply 2313H Hitachi	Plane
1ply 1080 Hitachi regular	
<b>0.005h/h Nelco-6</b>	Plane
1ply 2313H Hitachi	Signal
1ply 1080F Hitachi fill preg	
<b>0.008H/H STABLCOR</b>	STABLCOR, GND
1ply 1080F Hitachi fill preg	
1ply 106 Hitachi	Etch off
<b>0.005h/h Nelco-6</b>	Signal
1ply 2313H Hitachi	
1ply 1080F Hitachi fill preg	
<b>0.008H/H STABLCOR</b>	STABLCOR, GND
1ply 1080F Hitachi fill preg	
1ply 2313H Hitachi	Signal



Cross Section of PCB

# 12 Layer, Blind via STABLCOR PCB Layer stack-up

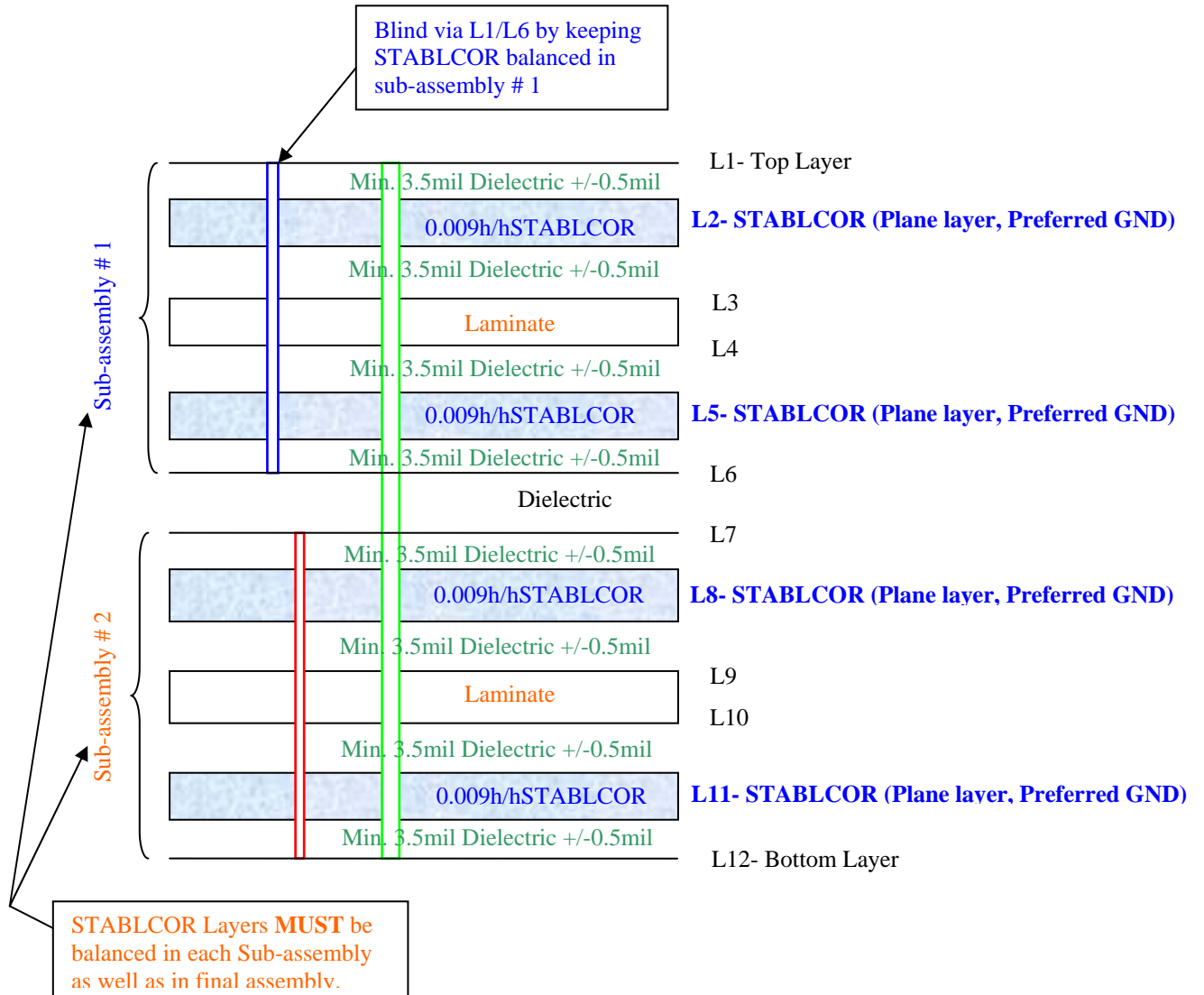
## \* Example # 3



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 12 Layer, Blind via STABLCOR PCB Layer stack-up

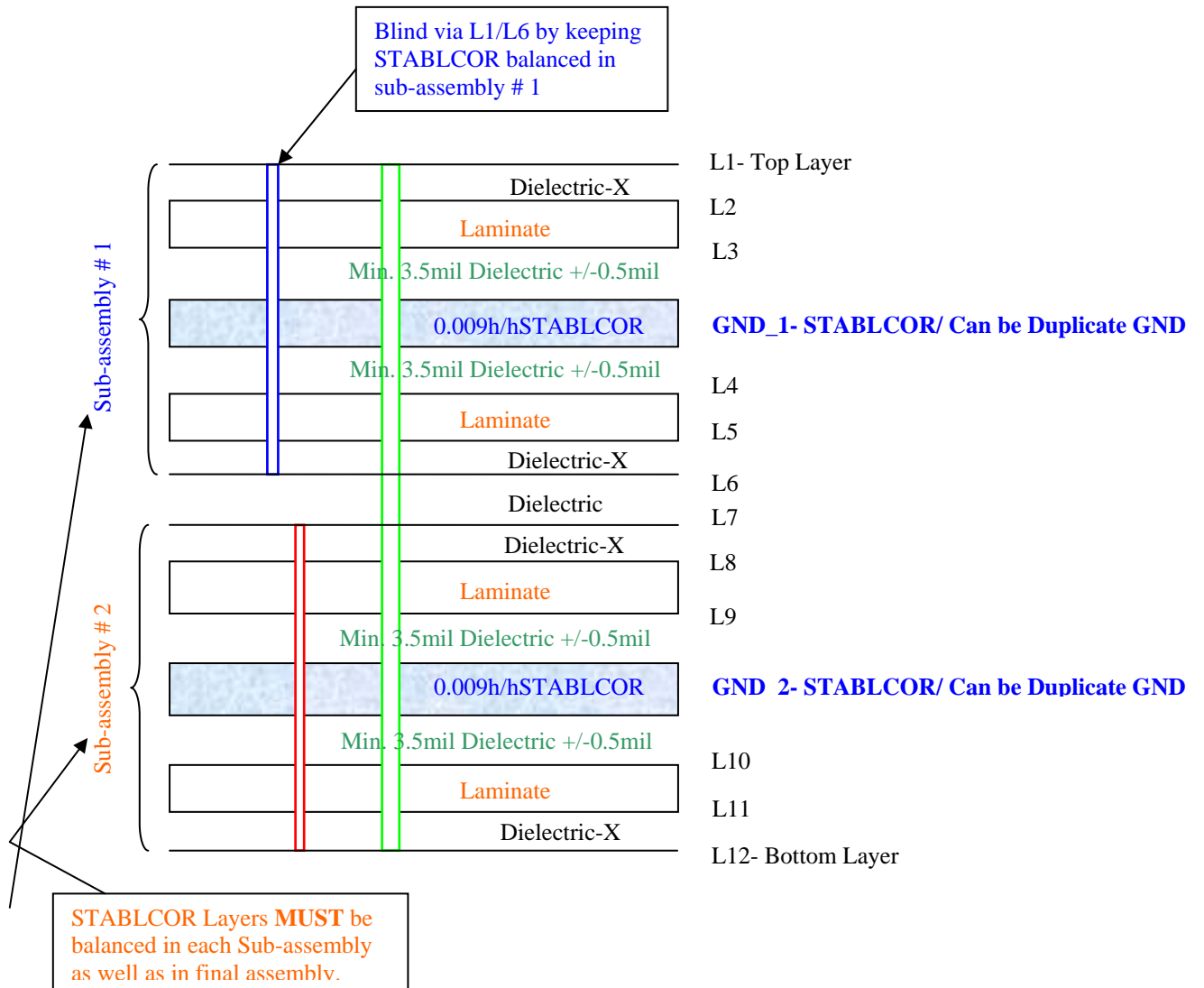
## \* Example # 4



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 12 Layer, Blind via STABLCOR PCB Layer stack-up

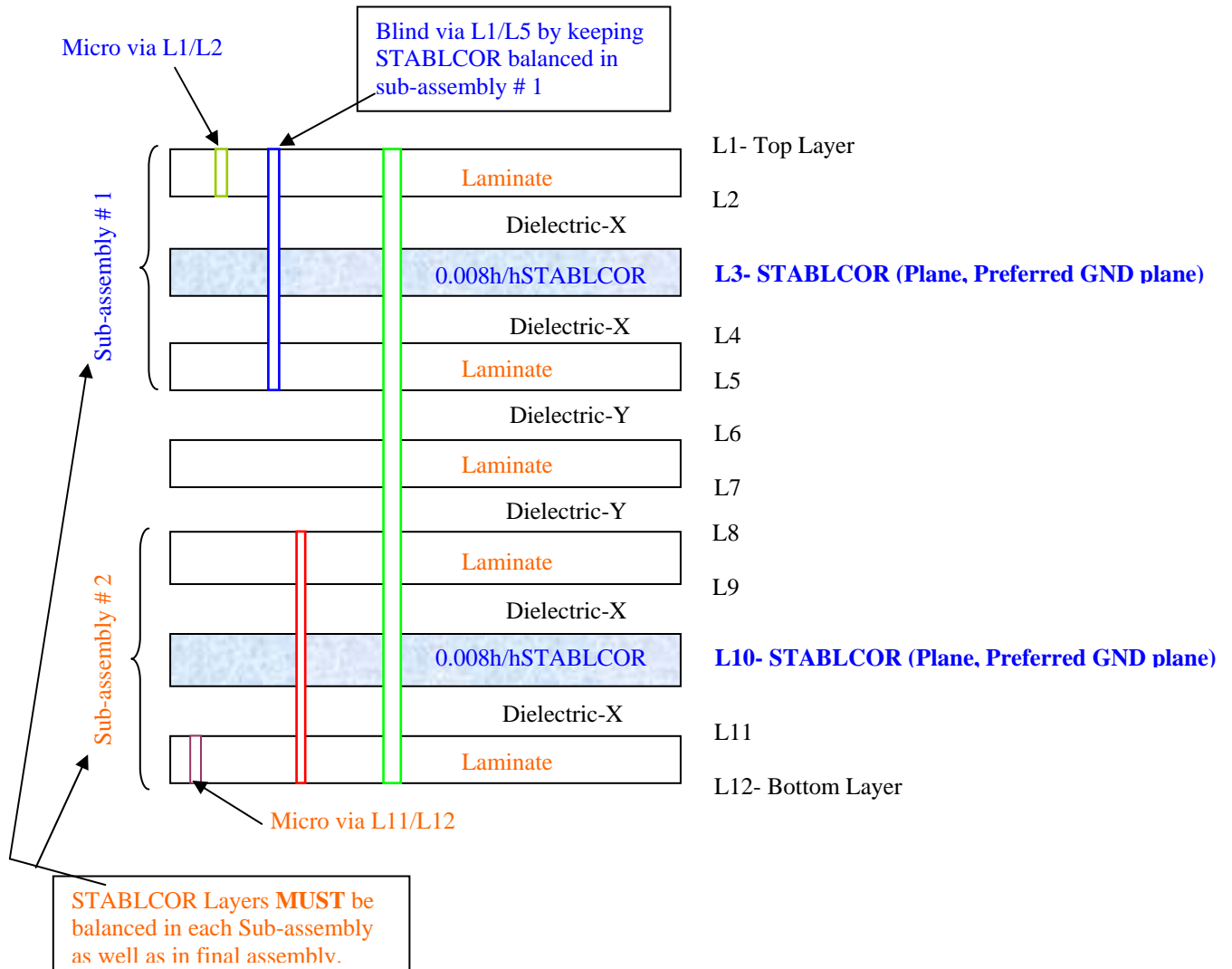
## \* Example # 5



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 12 Layer, micro via, buried & blind via STABLCOR PCB Layer stack-up

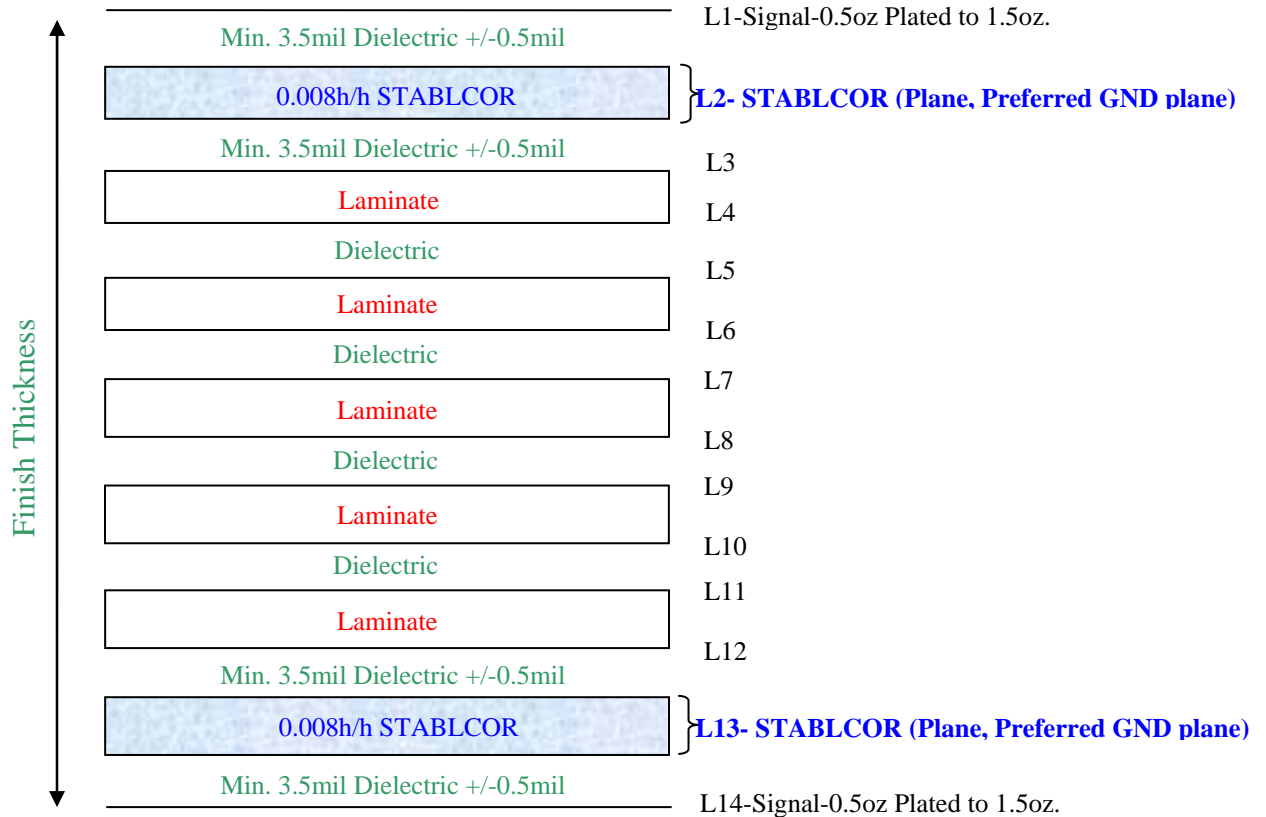
## \* Example # 6



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 14 Layer STABLCOR PCB Layer stack-up

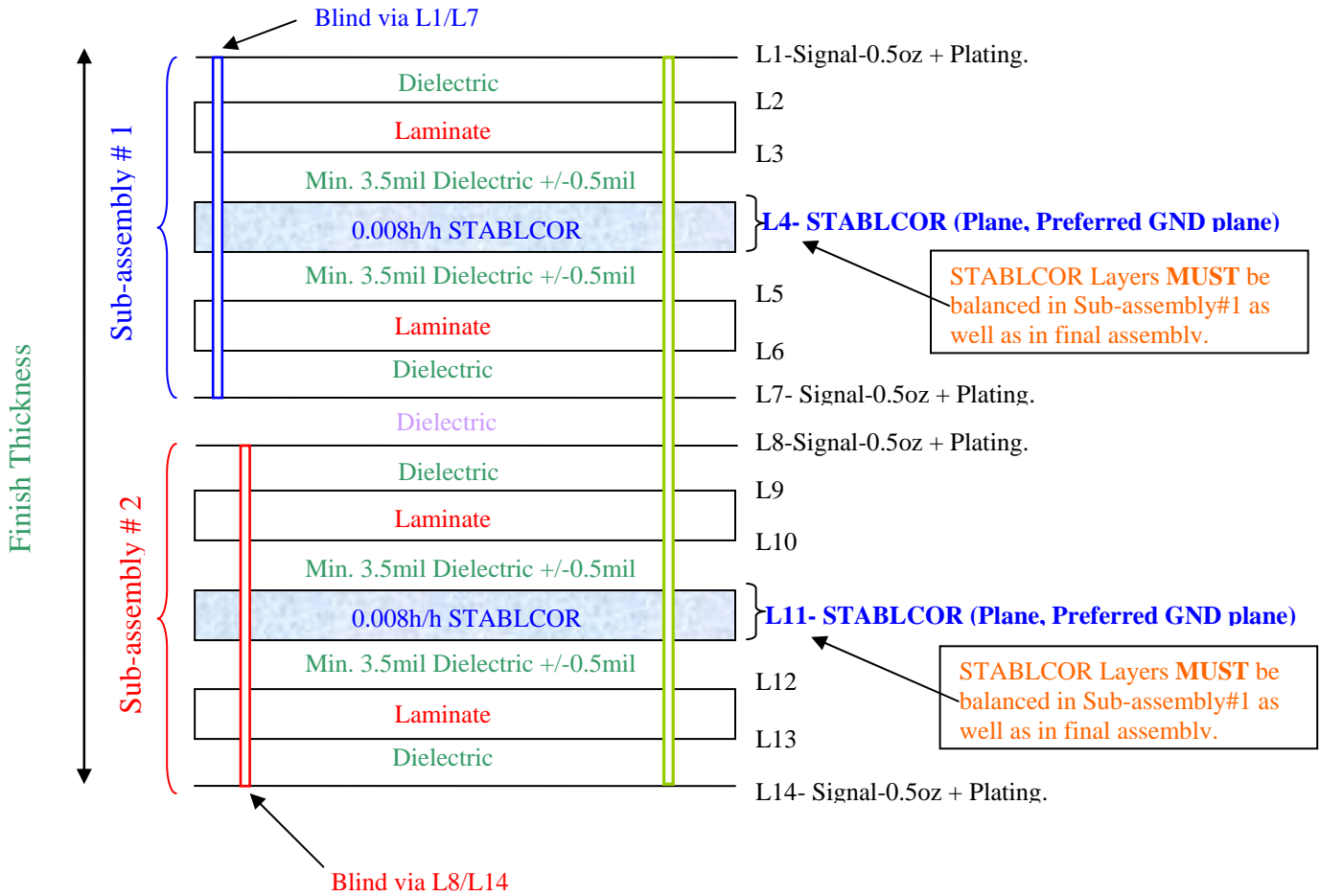
## \* Example # 1: STABLCOR at L2 and L13.



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 14 Layer, blind via STABLCOR PCB Layer stack-up

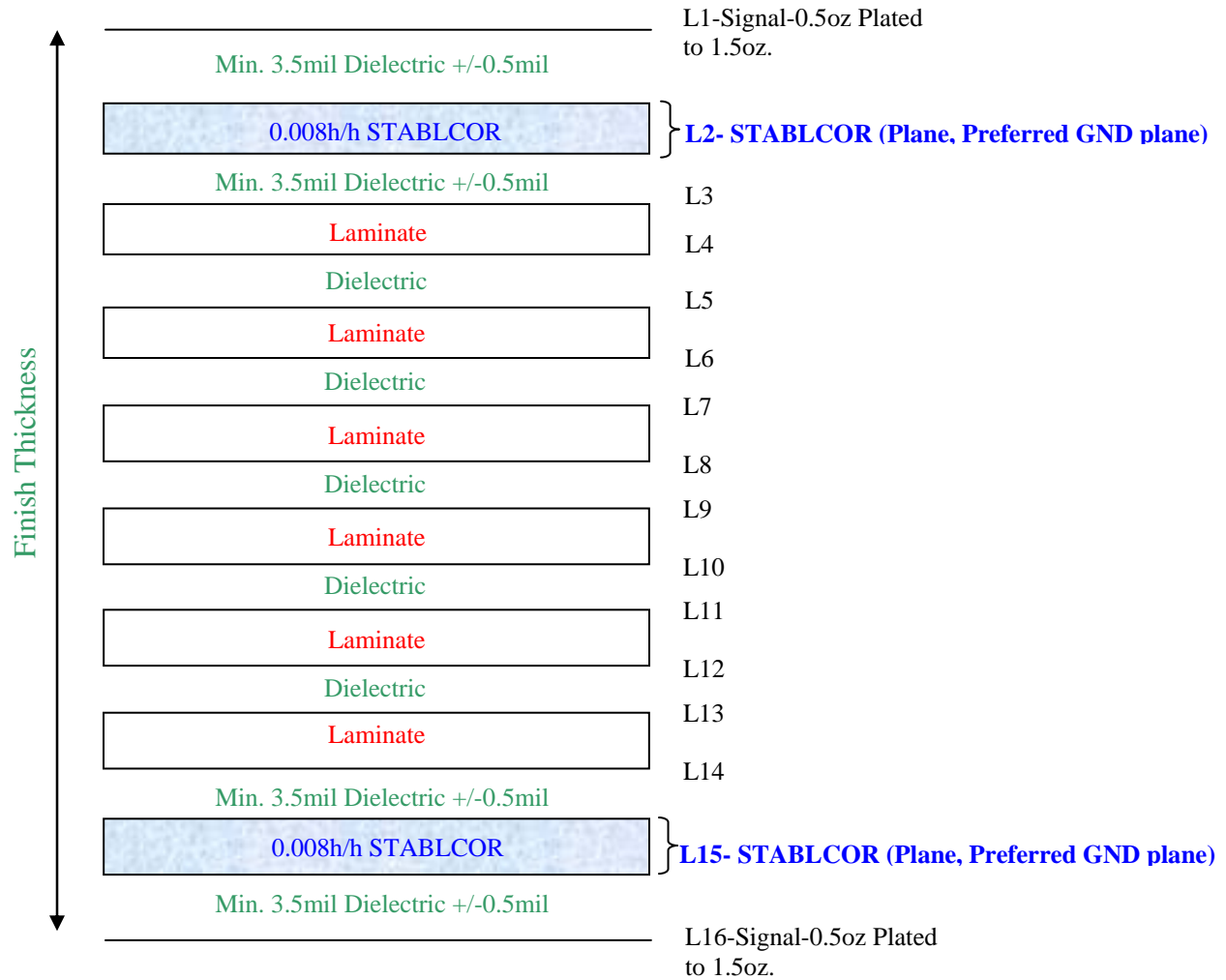
\* **Example # 2: STABLCOR at L4 and L11 with blind via.**



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 16 Layer STABLCOR PCB Layer stack-up

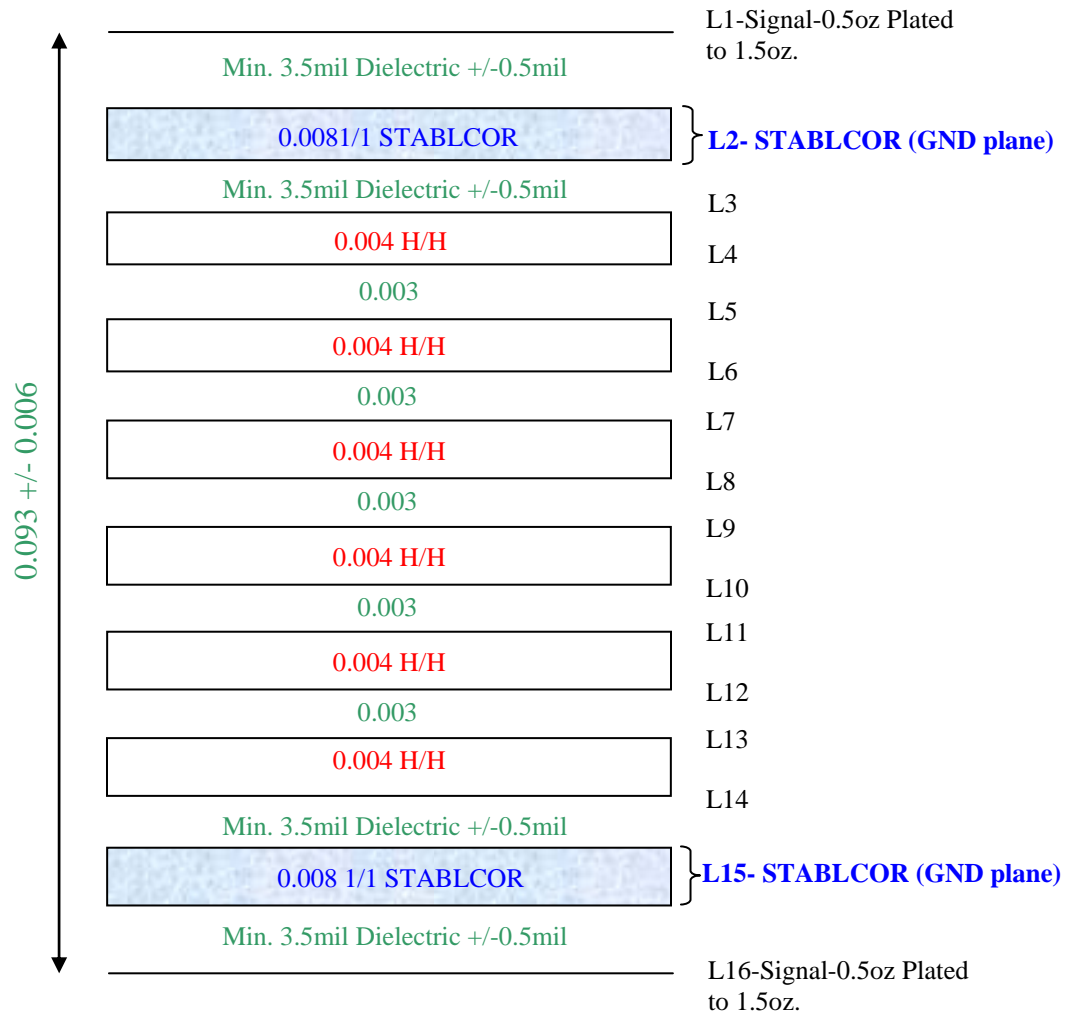
## \* Example # 1: STABLCOR at L2 and L15



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 16 Layer, 0.093” thick STABLCOR PCB Layer stack-up

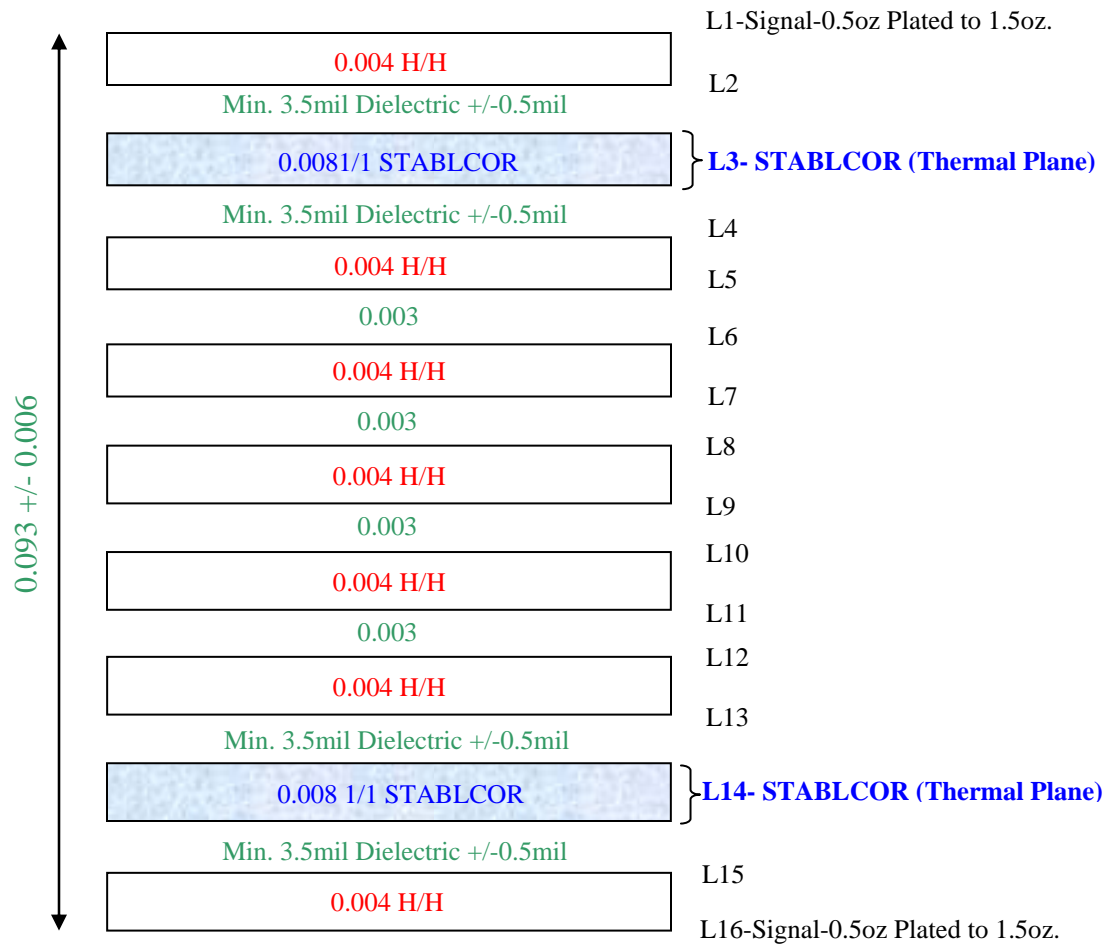
## \* Example # 2: STABLCOR at L2 and L15



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 16 Layer, 0.093” thick STABLCOR PCB Layer stack-up

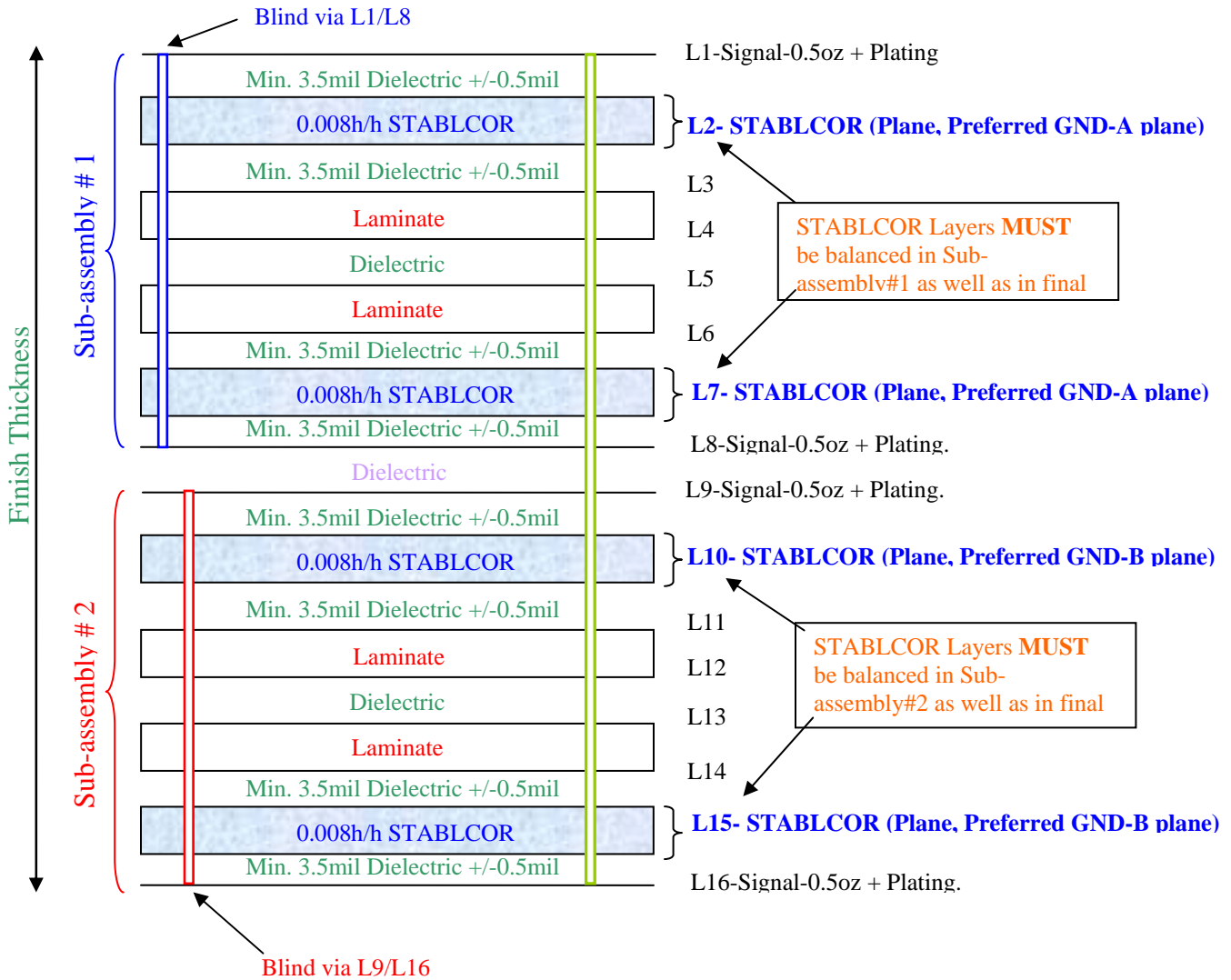
## \* Example # 3: STABLCOR at L3 and L14



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 16 Layer, blind via STABLCOR PCB Layer stack-up

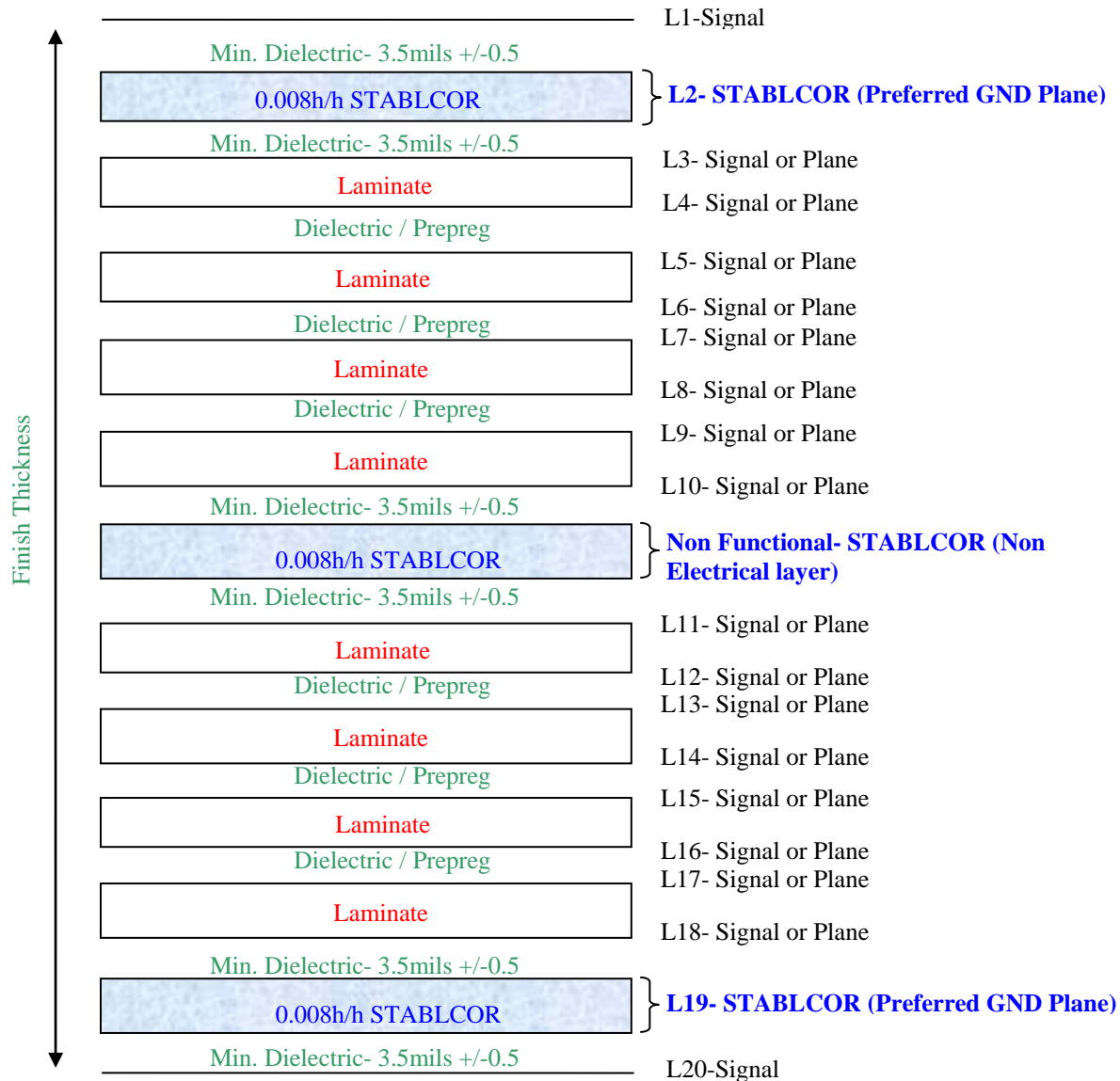
\* **Example # 4: STABLCOR at L2, L7, L10 and L15 with blind via.**



**Note: This is the example. Stack-up can be modified to maintain impedance and other electrical performance.**

# 20 Layer STABLCOR PCB Layer stack-up

## \* Example # 1: STABLCOR at L2, Center and L19.



- Laminate: means it can be any dielectric laminate with necessary copper on both sides.
- STABLCOR can be any type from STABLCOR family. See type of STABLCOR available.
- This is the example. Stack-up can be modified to maintain impedance and other electrical performance.

## 20 Layer STABLCOR PCB Layer stack-up

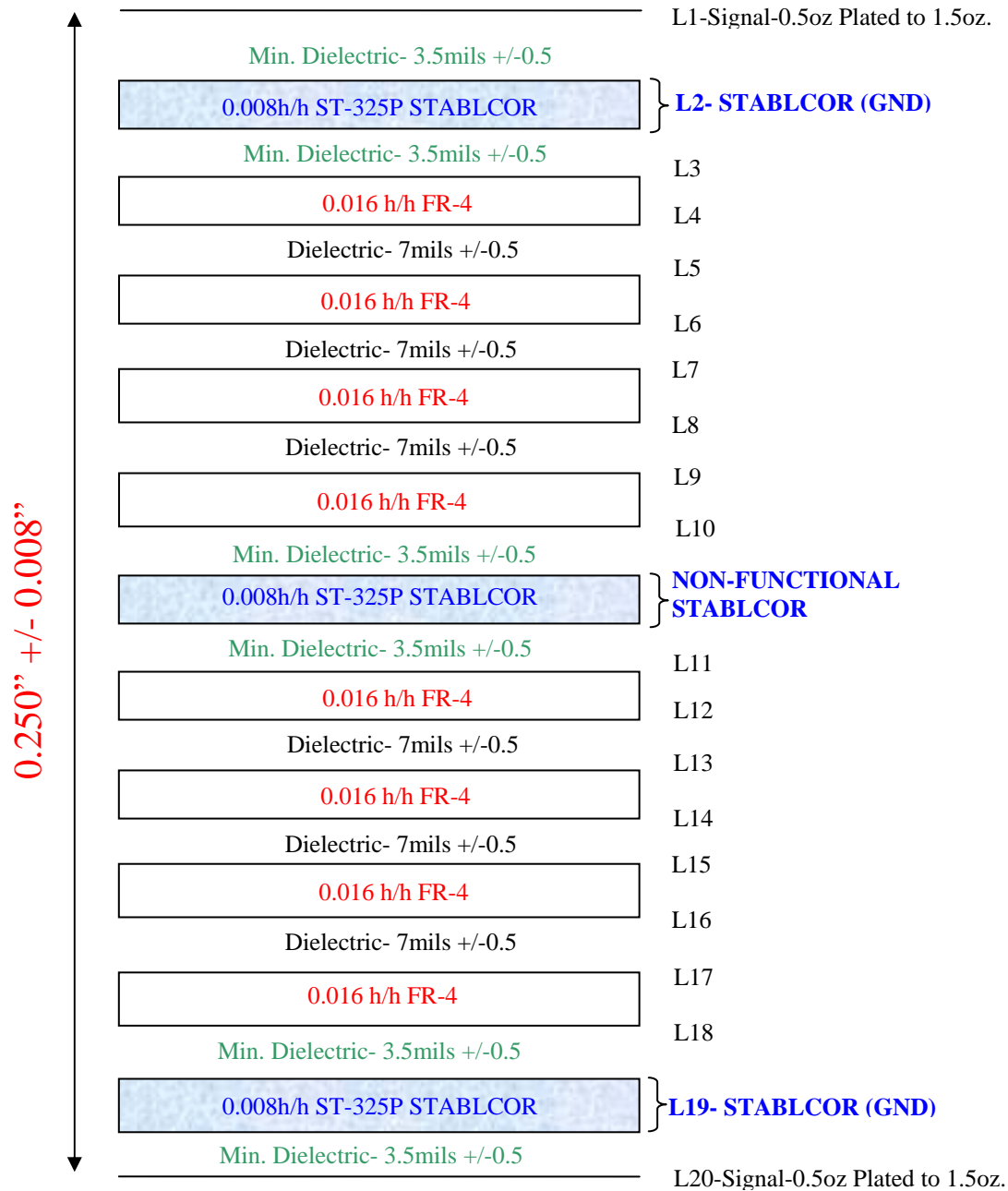
### \* Example # 2: STABLCOR at L6, Center and L15.



- Laminate: means it can be any dielectric laminate with necessary copper on both sides.
- STABLCOR can be any type from STABLCOR family. See type of STABLCOR available.
- This is the example. Stack-up can be modified to maintain impedance and other electrical performance.

# 20 Layer, 0.250" STABLCOR PCB Lay-up

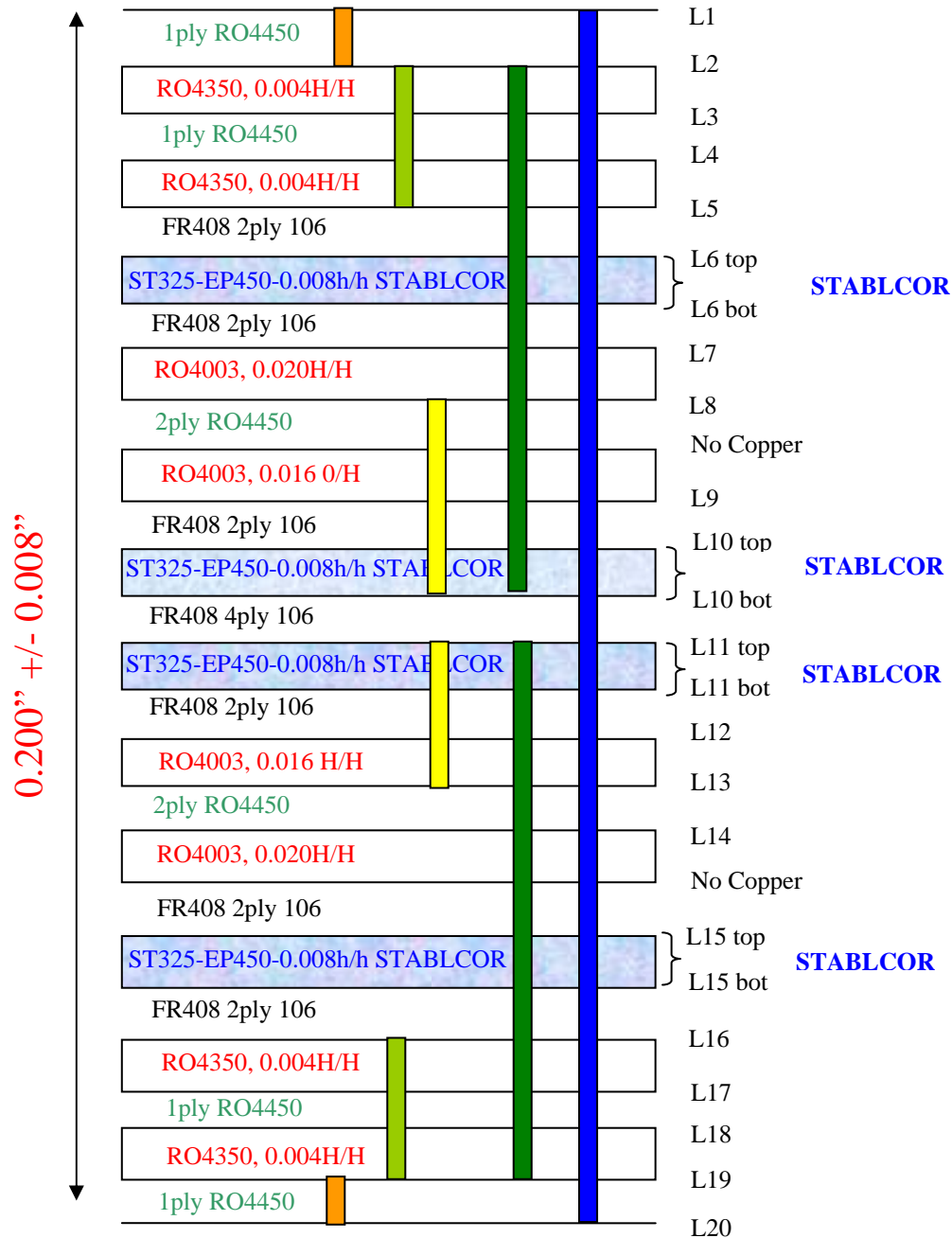
## \* Example # 3



- STABLCOR can be any type from STABLCOR family. See type of STABLCOR available.
- This is the example. Stack-up can be modified to maintain impedance and other electrical performance

# Actual 20 Layer, Blind, Buried via 0.200" STABLCOR PCB Lay-up

## Example #4



Blind Via L1-L2, L19-L20, L2-10, L11-19

Buried Via: L2-5, L16-19, L8-10, L11-13

Through Hole: L1-20

STABLCOR layers L10 and L11 will see 3 lam cycles and L6, L15 will go through 2cycles