Stress (Strain) Equation
Calculating Stress on CCGA

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December 1, 2015

What causes stress (strain)?

Stress (Strain) is created whenever different materials are joined together over varying temperatures.

Solder columns absorb stress between ceramic packages and the PC board.

Ceramic has a coefficient of thermal expansion (CTE) of ~7.5ppm/^{o}C.

PC boards have a CTE of roughly ~17.5ppm/^{o}C

This causes a 10ppm/^{o}C difference between the ceramic module and the PC board.

The larger the DNP (Distance from Neutral Point) of ceramic module, the more stress (strain) is created at the solder joints.

CBGA solder ball (joints) stretch and squeeze as temperatures change from hot to cold.

Eventually, the solder ball will delaminate - either at the ceramic package or at the PC board.

Let's look at the equation, to understand more about stress (strain).

$$\Delta x = DNP * \Delta T * (CTE_1 - CTE_2)$$

DNP – Distance from Neutral Point
ΔT - Temperature change
CTE_1 – Glass-Epoxy
CTE_2 – Ceramic

Δx is the change in stress (strain).

DNP is the distance from the "NEUTRAL POINT" - measured from the center of the component.

ΔT is the change in the temperature (for example minus -40 ^{o}C to +100 ^{o}C, the total is 140 ^{o}C)

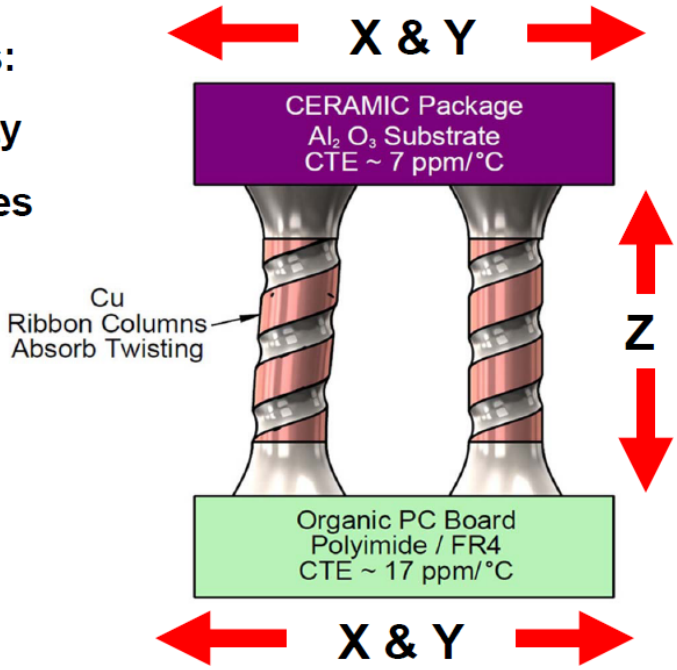
CTE is the coefficient of thermal expansions found in the data sheets of the materials.

Solder Columns Absorb Stress

CTE Mismatch ~ 10ppm/°C

CCGA Provides:

- **More Reliability**
- **More Life Cycles**



"SAFE HARBOR"
When it is safe to use of CBGA Ball Array?
When is it required to use a CCGA - Column Grid Array?

<table>
<tr><th>Component Size</th><th>Δ T
±75°C</th><th>Δ T
±125°C</th><th>Δ T
±165°C</th></tr>
<tr><td><15 x 15mm</td><td>BGA</td><td>BGA</td><td>BGA</td></tr>
<tr><td>25 x 25mm</td><td>BGA</td><td rowspan="3">BGA
Use with Caution !</td><td rowspan="3">CCGA</td></tr>
<tr><td>31 x 31mm</td><td rowspan="2">BGA
Use with Caution !</td></tr>
<tr><td>35 x 35mm</td></tr>
<tr><td>>40 x 40mm</td><td>CCGA</td><td>CCGA</td><td>CCGA</td></tr>
</table>

"GREEN" represents the safe use of CBGA - ceramic ball grid array.

It is generally safe to use CBGA with package size 15mm or smaller.

Small CBGA components will not experience a significant CTE mismatch.

Exercise caution if the ceramic component is 25mm or more, especially if the operating temperature will swing more than +/- 125 ^{o}C.

Large CBGA will fail (electrical delamination) after multiple thermal cycles of +/- 125 ^{o}C.

It is recommended to use CCGA (Column Grid Array) when ceramic packages exceed 27mm square.

DNP - Distance from Neutral Point
Calculating DNP on CCGA

DNP is an acronym for "**D**istance from **N**eutral **P**oint".

The maximum DNP is the linear distance measured from the center of the package to the corner pads.

Units of DNP can be either metric (mm or um) or imperial (inches or mils), as long as it is consistent with other units of measures in the stress (strain) formula shown on page 3.

The larger (longer) the DNP, the more stress (strain) will be experienced at the pads, columns or balls on an array package.

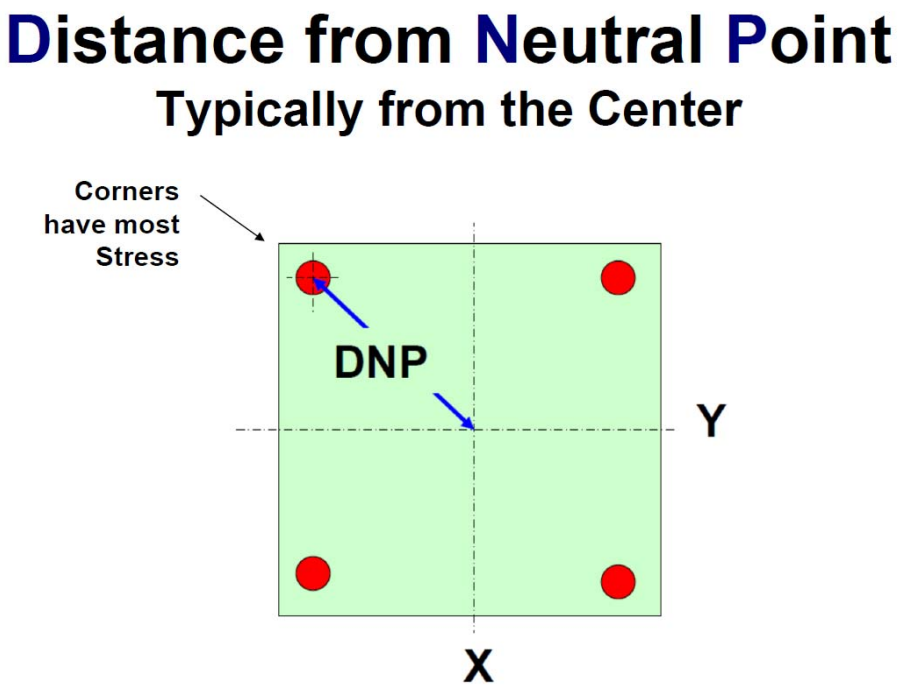
Failures (delamination) caused by stress (strain) are typically the pads at the corners of the substrate located furthest from the center, as well as the corners under the silicon die (or flip-chip).

By way of example, let's assume the substrate (X or Y) is 35 x 35mm.

For square substrates, the DNP is one-half of X (or Y) multiplied by the square root of 2.

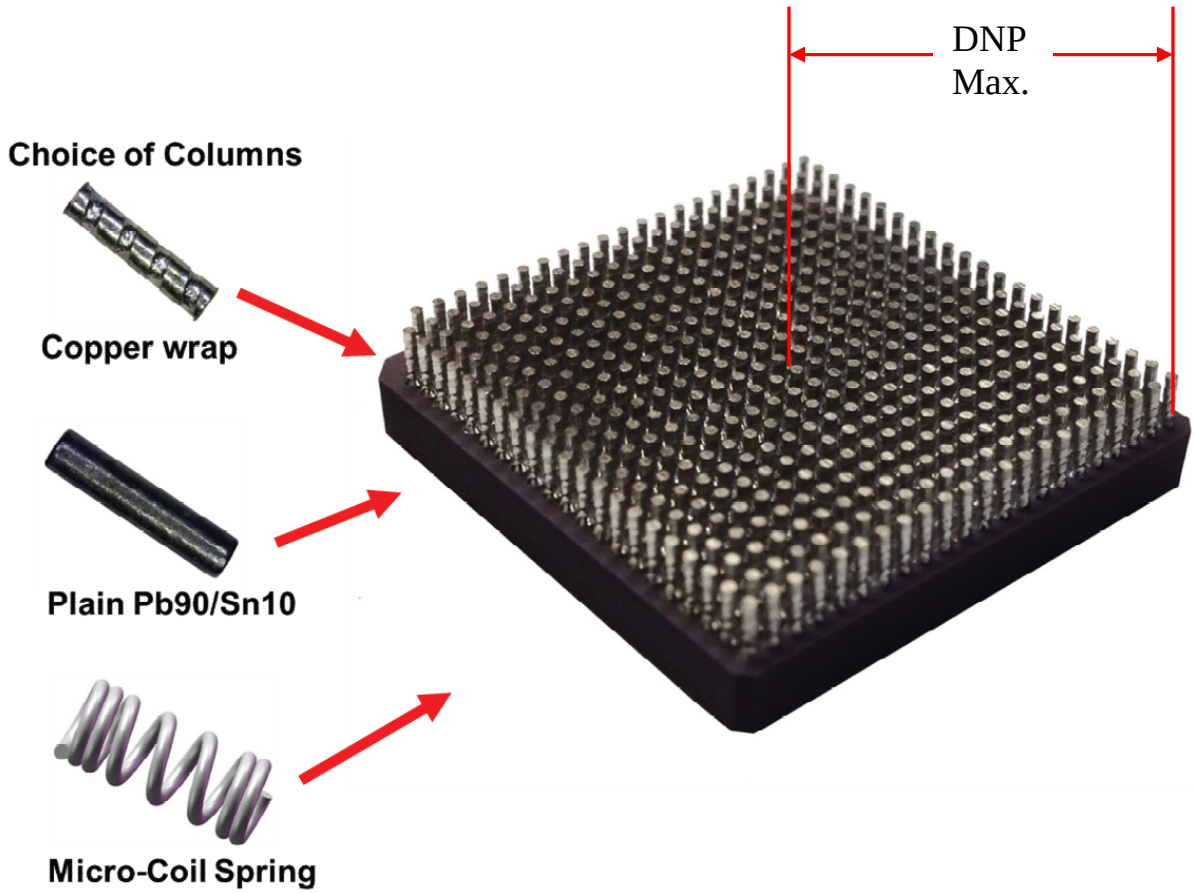
Therefore, DNP to the corners of a 35mm square package is roughly 24.75mm (rounded)

$$DNP = \sqrt{2} * (X/2)$$



Maximum DNP
Maximum Distance From Neutral Point

The maximum DNP is the linear distance from the center of the package to the corners.



For more information, visit **www.CCGA.co** (not .com)