

TADCO LAMINATION PLATES

PERFORMANCE ANALYSIS

Teradyne
Circuits Division
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Paul Lukitsch

Preface – Past History

In November of 1988, I performed an evaluation of four suppliers of lamination plates. This evaluation was intended to give Teradyne's management and me a basic understanding of the performance of the different suppliers of lamination plates. The following is a brief summary of the 1988 test and results.

Plate size = 26" x 30"

Panel size = 24" x 28"

Four different manufacturers

All plates 0.375" thickness

Two sets from each supplier

Supplier	Material	Cost/Set	Total Cost
Multiline	Bohler 630	\$3,079	\$6,158
Picard	AISI-420	\$4,144	\$8,288
TADCO	AISI-4140	\$2,339	\$4,678
G&G Machine	Low Carbon Steel	\$2,150	\$4,300

This analysis was performed by purchasing two sets of plates from each supplier and monitoring the **Flatness** and **Integrity** (bushing condition, surface appearance) of each plate for six months. The results were as follows:

Supplier	Material	Plates Under 2(mils/inch)	Plates Over 2(mils/inch)
Multiline	Bohler 630	4	0
Picard	AISI-420	4	0
TADCO	AISI-4140	4	0
G&G Machine	Low Carbon Steel	1	3

Notes:

The Multiline bushings have experienced cracking/breakage.

The Picard does not use a bushing. The holes in the plates have started to become distorted and/or deformed.

The TADCO bushings are in excellent shape. None have experienced cracking and/or breakage.

Introduction

Since the test back in 1988, Teradyne has made a serious investment in new lamination plates from TADCO. This investment has proven to be a beneficial improvement to our lamination process. The complexity of the backpanels produced at Teradyne has evolved from **8-10** layer panels (**0.125"** thick) in 1988 @ a panel size of **24"x28"**, to **33** layer (**0.435"** thick) **36" x42"** panels in 1992. This type of radical change would only be possible with excellent lamination tooling and tight control of this tooling.

The following report is a summary of the process I use to control this tooling, the longevity of the TADCO lamination tooling plate and bushings, and how this control relates to the final product.

Lamination Plate Inspection

A regular lamination plate inspection determines the warpage of the plates from thermal cycling. This warpage in a lamination plate can produce the following defects in the final product:

Non-Uniform Panel Thickness

There can be a large variation in panel thickness, up to 10 mils or greater, on the panels adjacent to the lamination plates.

Non-Uniform Dielectrics

This can cause circuits to have incorrect impedance values.

This can cause unnecessary rejections for dielectrics measured on coupons which do not match the actual dielectrics on the circuits.

The plate inspection is performed by placing a feeler gauge under a good quality straight edge placed diagonally across the **concave** side of the lamination plate. **NOTE:** this test uses a 24" straight edge. A longer straight edge may be necessary if the diagonal of the plate exceeds 24".

- If a 0.24" feeler gauge **does not** fit under the straight edge, the plate is logged in as **Flat**.
- If a 0.24" feeler gauge **does** fit under the straight edge, the plate is logged in as having **1 mil/inch warpage**.
- If a 0.48" feeler gauges **does** fit under the straight edge, the plate is logged in as having **2 mil/inch warpage**.
- If >0.48" feeler gauge **does** fit under the straight edge, the plate is logged in as having **>2 mil/inch warpage** and is **rejected** and no longer used.

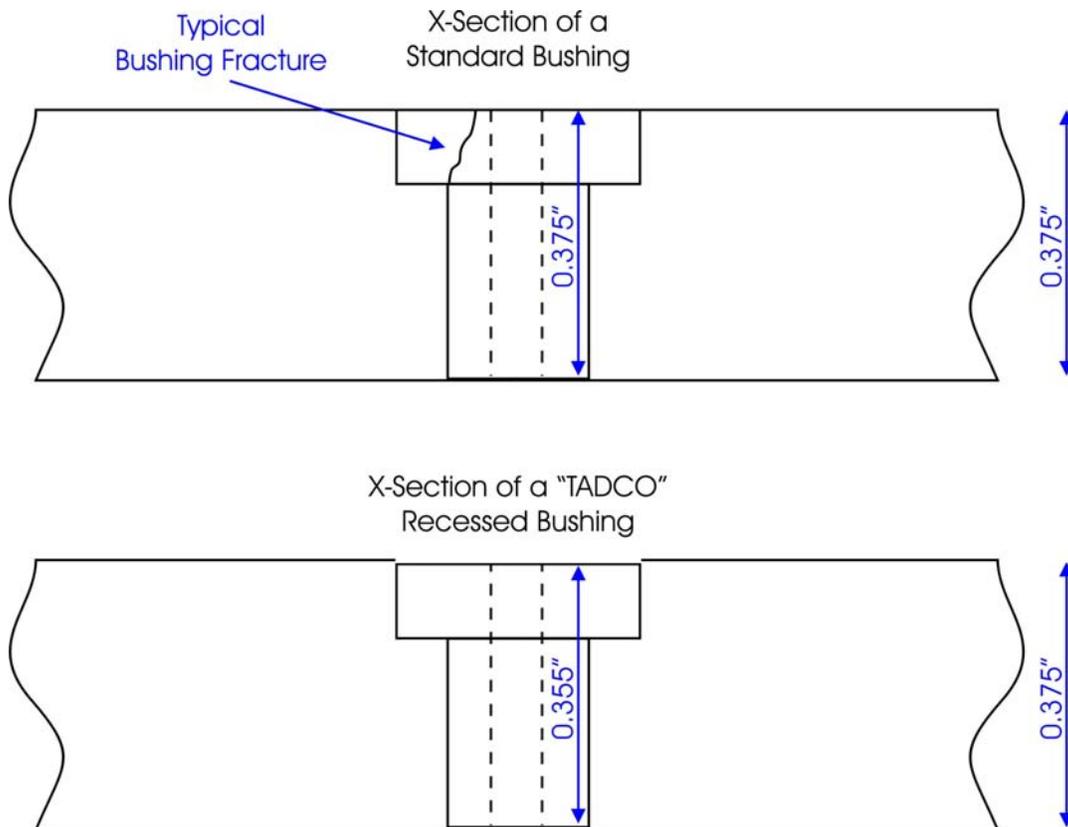
This simple inspection has added an important level of control to the process. From this inspection we are able to determine what plates are going to fail within a given period of time. This gives us a very accurate assessment of the condition of all of the lamination plates in our stock. This information is stored on a computer and allows us to update and recall our last inspection very easily.

Lamination Plate Longevity: Flatness

Since 1988, Teradyne has purchased about 200 lamination plates from TADCO. We have not rejected or thrown away **any** lamination plates thus far for warping out of the usable specification range. This is a major improvement over our past experiences with the other plate manufacturers. Typically, we could only count on 2 or 3 years of service from a lamination plate before it would warp out of usable condition. The long life of these plates through continuous cycling confirms that TADCO tightly controls the heat treating process. One of our first set of plates purchased from TADCO in 1988, 18x24 panel size, is still less than 1 mil/inch. These plates are used three shifts per day.

Lamination Plate Bushing Life

TADCO has designed in their plates a specially sized bushing that lasts longer than other manufacturer's bushings. This bushing is shorter than the thickness of the lamination plate and is recessed into the plate. This shorter bushing design leads to a longer-lasting bushing. The bushing lasts longer than the industry standard bushing because the lamination press pressure is not exerting force on the HAT portion of the bushing. The recessed design eliminates the lamination press pressure that fractures the hat of the bushing. The first diagram below illustrates the typical bushing failures that we have experienced with other brands of lamination plates that do not use the TADCO recessed bushing design.



Effect on Final Product

The flatness of these plates is critical to ensure good results on the final product. The following is a histogram of the panel thickness for a 0.315" thick backpanel that Teradyne produces. The tight thickness distribution illustrates little variation within all plate sets used. This panel covers a large amount of real estate; the panel size is 18" x 41". Achieving world class results of a $C_p=2.83$ would only be possible if the plate sets were within the inspection criteria I described earlier. (Note: $> 1.33 C_{pk}$ is 6 sigma: considered world class.)

Panel Thickness Histogram

