Manufacturing of multilayer ceramic capacitors by laser machining

CNES-Exxelia contract n° 180649/00

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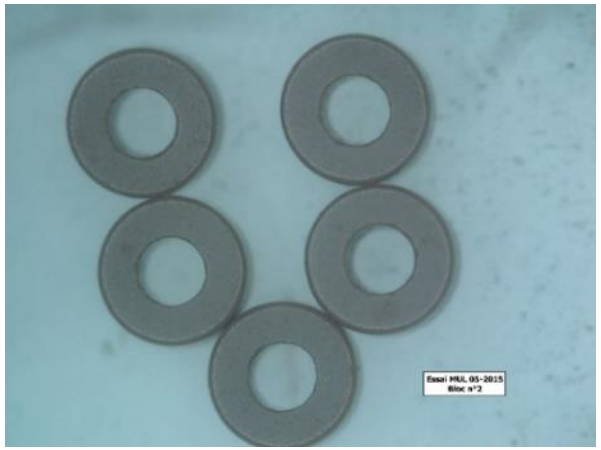
www.exxelia.com

Why laser machining ?

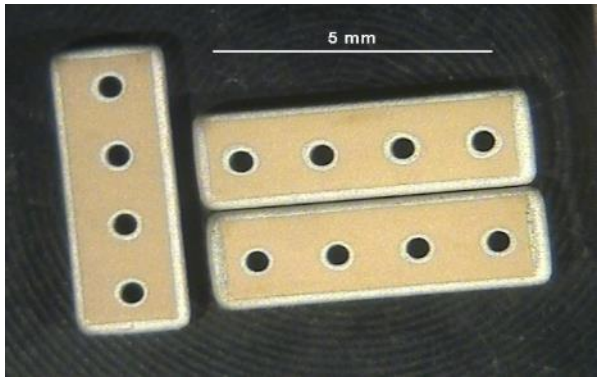
- Exxelia's core target has always been and is still high reliability passive components conception, development and supply, both standard and custom-design models
- For MLCC's, it means (among others) development of various designs, to fit customer requirements
- Classical MLCC's manufacturing technologies allow to build only parallelipidedic or circular capacitors
- The aim here is to test a method to be able to build various shapes, needed in particular (but not only) for filtering (feed-through) applications
- Study is in progress (with help of CNES), to build and test filtering MLCC's, mono or multi capacitances, with miniaturized circular shapes or custom-design shapes

⇨ **laser machining**

Examples of previous developments, mechanical machining



Single capacitance miniaturized model

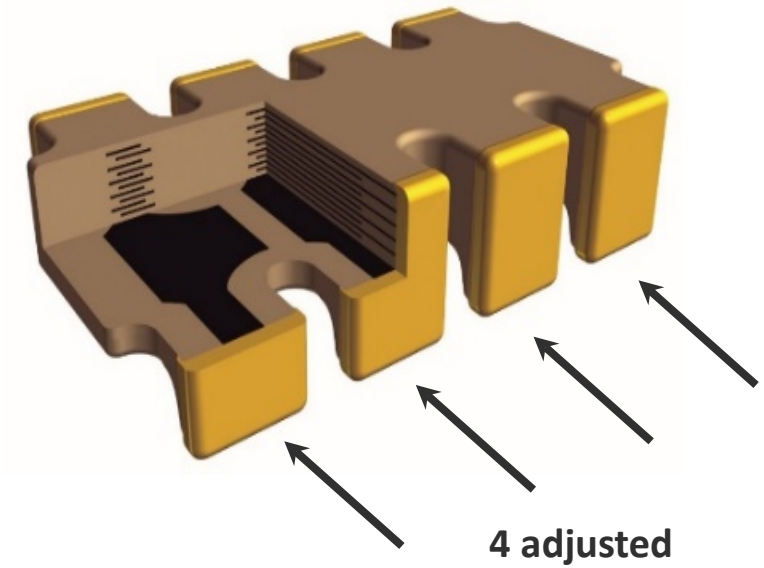


Multicapacitance custom-design miniaturized model

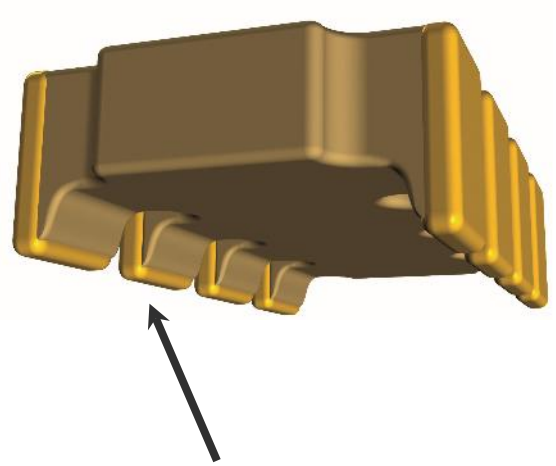
Multi capacitance miniaturized model

Examples of previous developments, laser machining

Multicapacitance custom-design miniaturized model



4 adjusted capacitances



‘’ Washing foot’’

1206 size

Laser machining benefit pour MLCC's custom design manufacturing

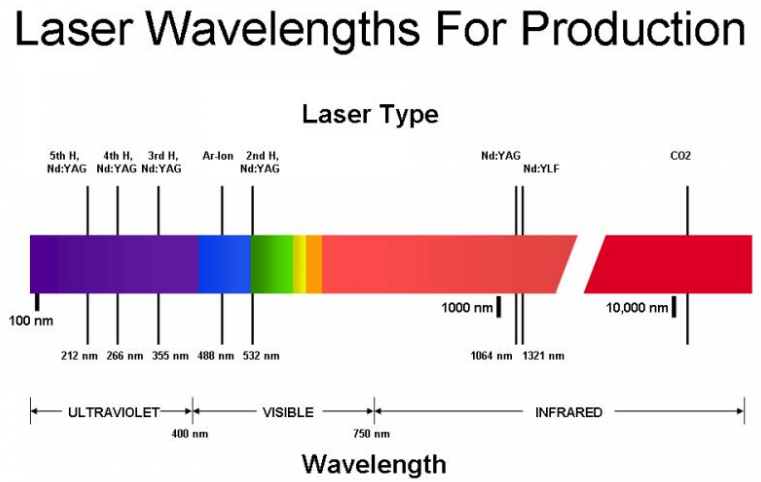
Why UV laser ?

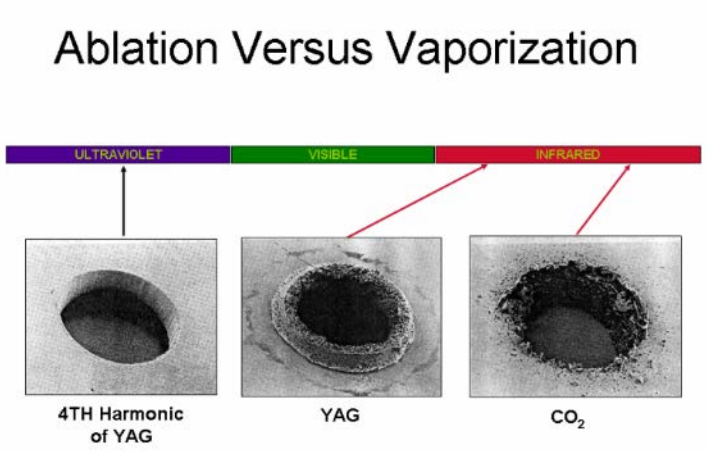
Photons emitted in the UV spectra have an energy much higher than those emitted in IR.

Absorbed photons give a cinetic energy that brake links of matter's molecules ; particles are ejected with a very high speed = **photochemical ablation**.

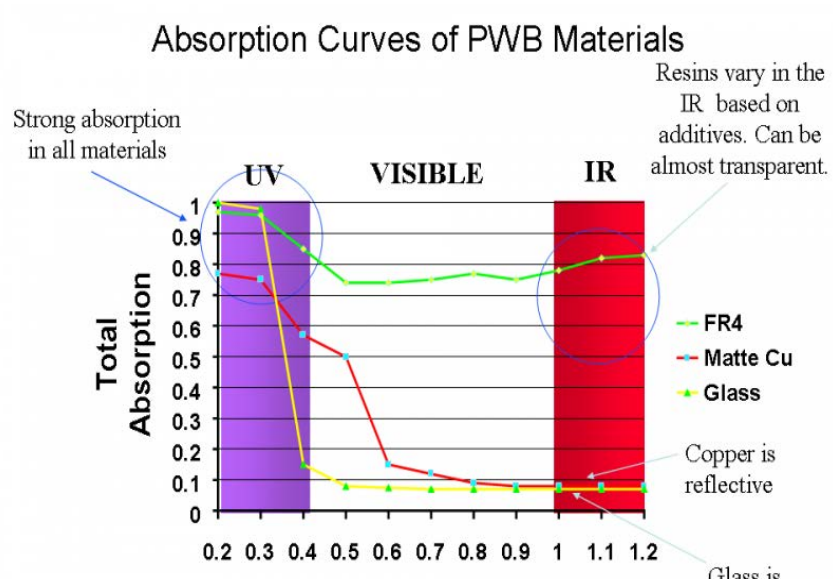
LASER energy emitted in UV spectra is absorbed by metallic materials (copper, steel, aluminium…) as well as by insulating materials (polymers, ceramics, industrial diamond…)

M.U.L. use LASER sources with UV (355nm) emission to carry out custom-design micromachining





Drilling of the same material using lasers of different wavelength



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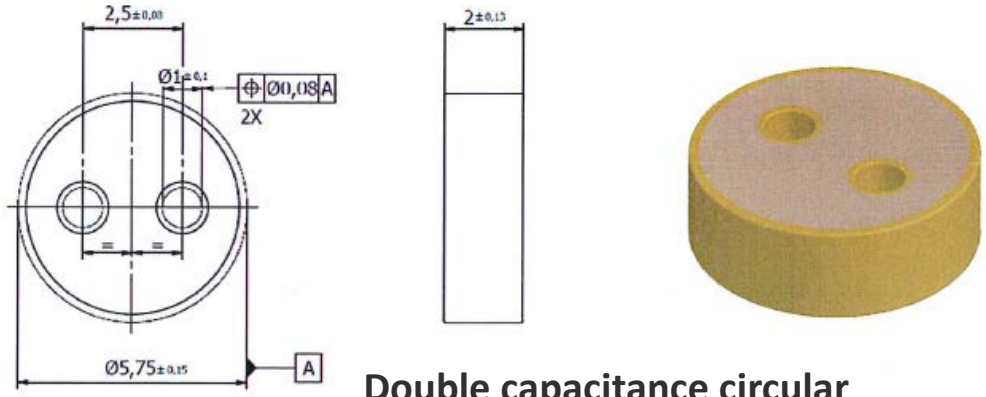
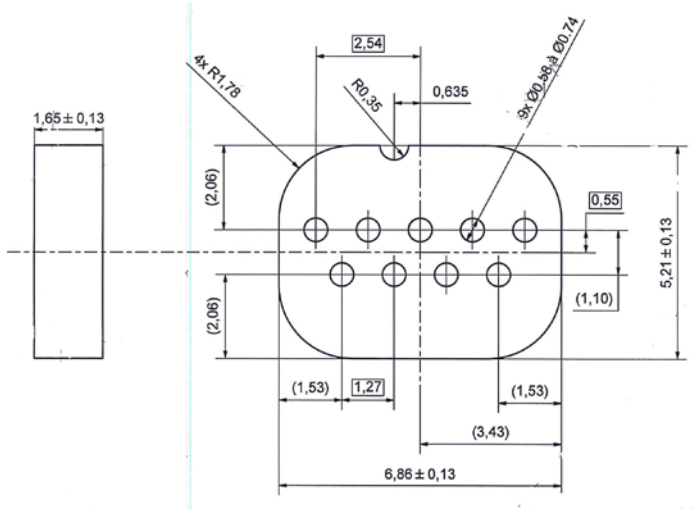
Test vehicles for evaluation of laser machining

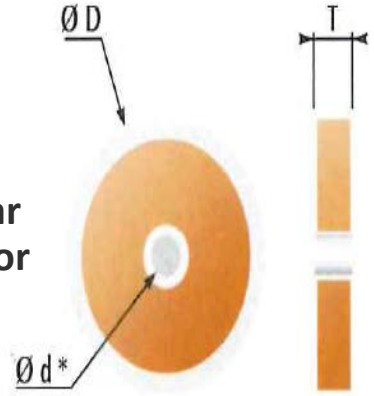


Double capacitance circular feedthrough capacitor



Multi capacitance custom design shape feedthrough capacitor

Single capacitance circular feedthrough mini capacitor



D = 1,4mm (-0,1/0)

d = 0,5mm (0/+0,05)

T = 1 mm max

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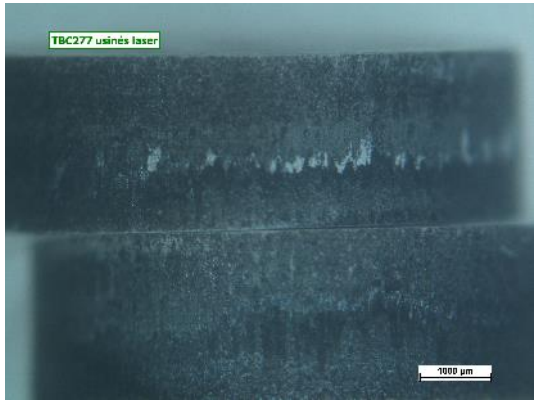
Green ceramics laser machining : first trials on standard ‘’TBC’’

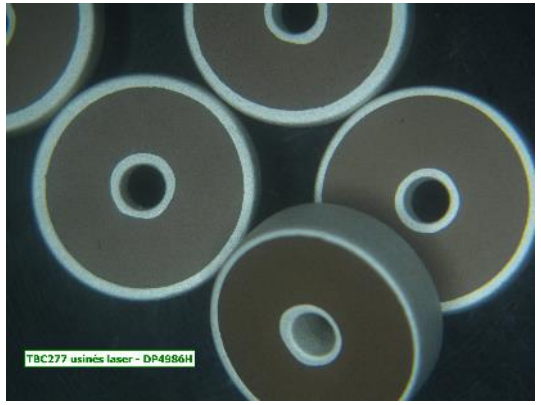
Laminated green block after laser machining, MLCC’s still in place

Laminated green block after laser machining, MLCC’s removed

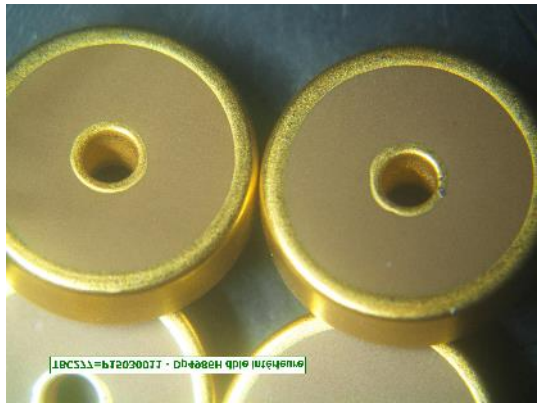


Green MLCC’s after laser machining

Laser machined circular MLCC’s, fired, grinded



Laser machined circular MLCC’s, terminated



Laser machined circular MLCC’s, gold plated

⇨ **Feasability validated**

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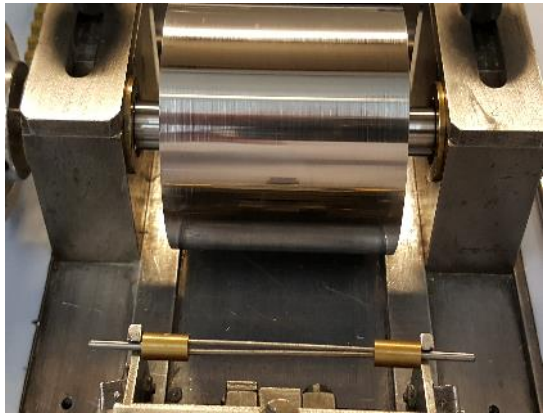
Multi capacitance custom design shape MLCC's development

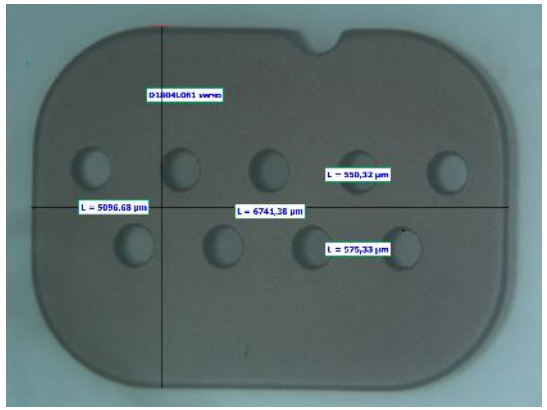
Green MLCC's after laser machining

Laser machined circular MLCC's, fired, grinded

Special tool for termination deposit on roll equipement



Green MLCC's after laser machining



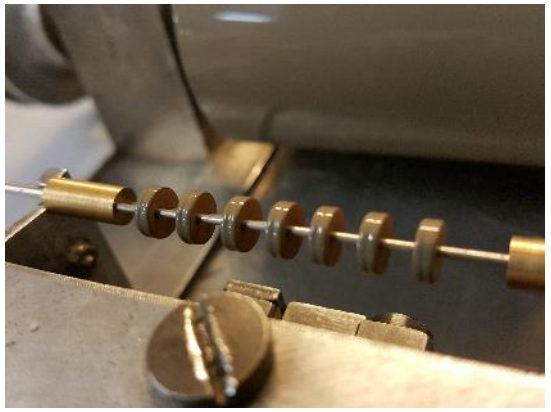
Laser machined custom design shape MLCC's, fired, grinded

New technology for termination deposit

Syringe on 4 axes robot deposit

Multi capacitance custom design shape MLCC's development

Green MLCC's after laser machining

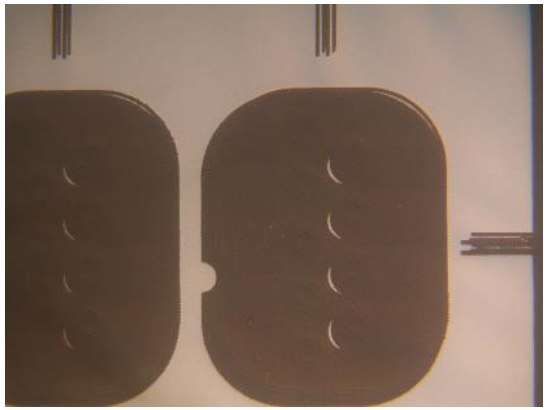


Terminated MLCC's

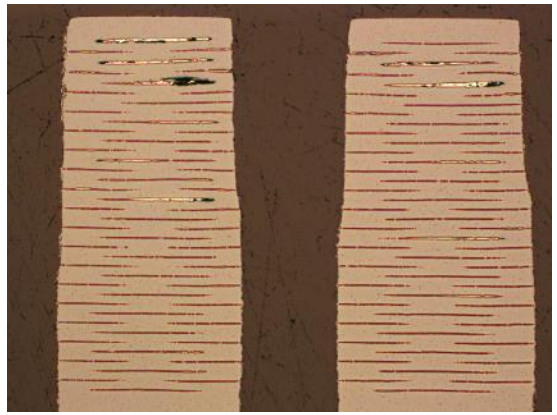
Gold plated parts,

2 x 50nF (0/ +100%) 200V

➡ Delivered to customer



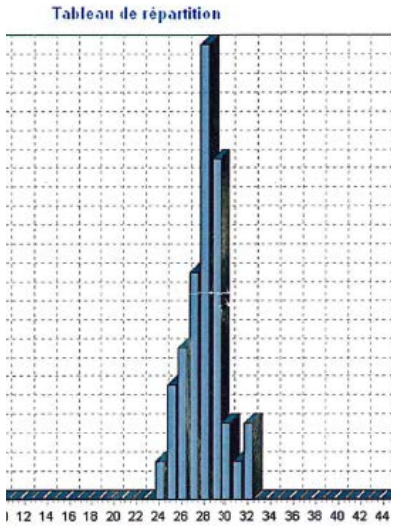
Overlay test of printing screens ⇨ to be improved



DPA : bad overlay ⇨ electrode shifting ⇨ shorts

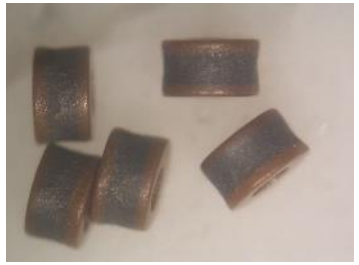
➡ Trials to be done on another manufacturing line, using optical centering ➡ Test in progress

Laser machining benefit for MLCC's custom design manufacturing



Close capacitance distribution (type 2 ceramic, 50nF each capacitance)

Trials to be done on parallelipipedic parts (vs blade cutting) to validate or invalidate this improvement

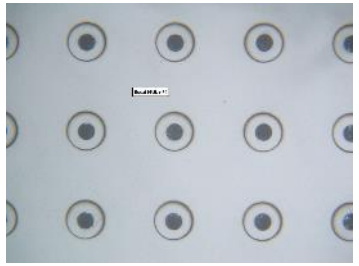


Micro-feedthrough MLCC's - Punching

Φ_{ext}=1,3-1,4mm

ϕ_{int}=0,5-0,55mm

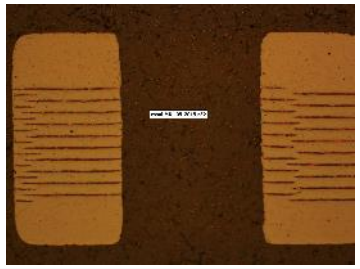
e = 1mm max



Micro-feedthrough MLCC's - Laser machining

More accurate

Better geometric definition



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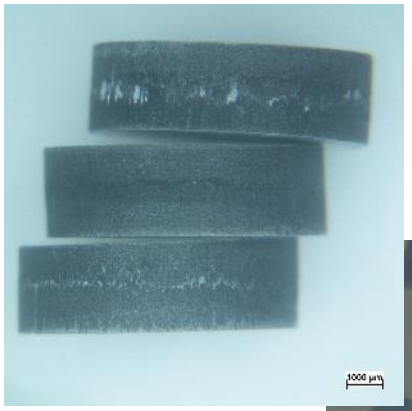
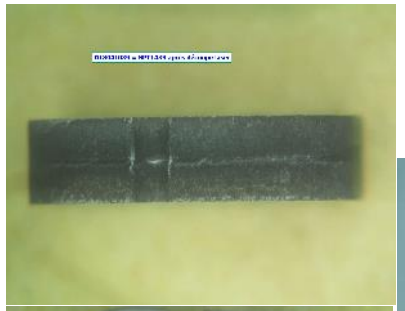
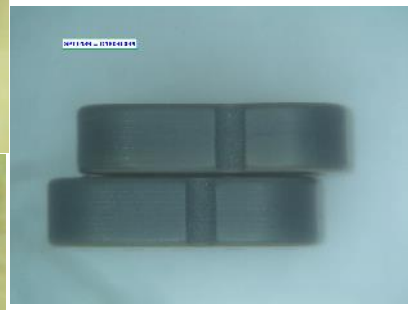
What do we have to improve ?



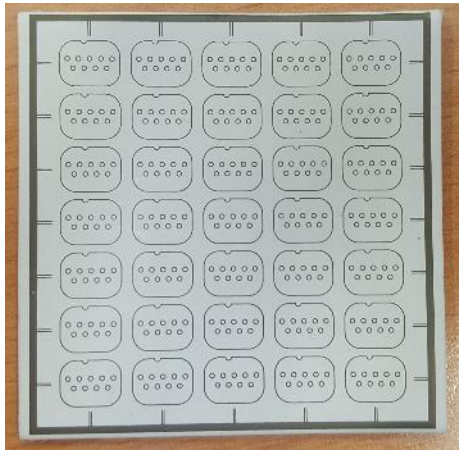


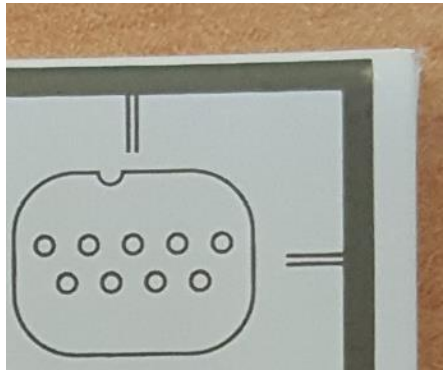


Up to 1mm thick, single-side machining

Thicker than 1mm, double-side machining needed

⇨ **matching after rollover**





Machining marker needed

⇨ **one more printing screen**

Thanks a lot for your attention

Maybe you have some questions ?

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