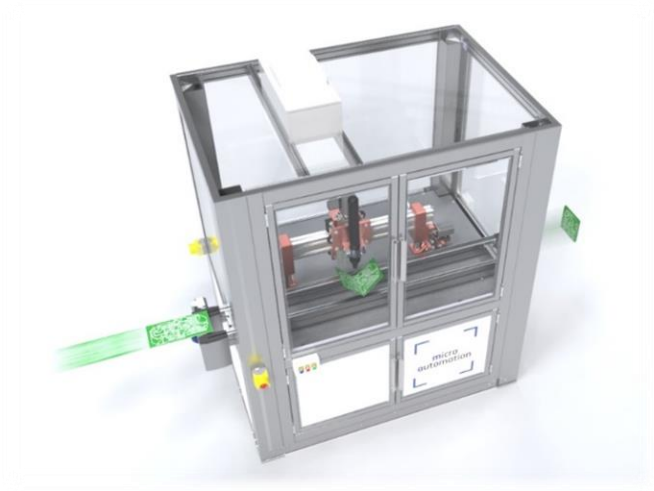
Automated PCB Folding for Wearable Applications



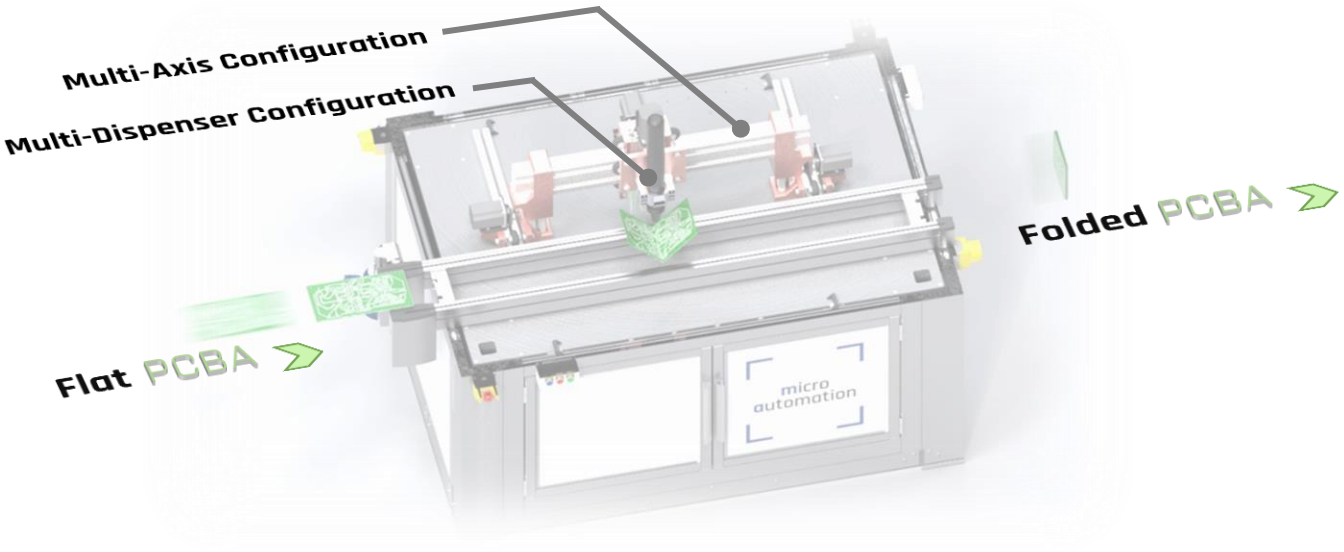
There is a growing need for flexible hybrid electronics for wearable applications, in which the user may often wear electronics on body, on fabric or on skin[1]. Electronics in wearable applications may be subjected to stresses of daily motion and requires careful processing and ruggedization.

This challenge becomes even greater when scaling up and adopting automation in production lines. Unlike a human hand with 27 DoF (degrees of freedom) and hyper-sensitive skin, a machine is rigid and precise.

To meet this need, MA micro automation has developed a high performance automated folding solution for PCBs.

Process Overview

For a folded PCBA to maintain precise geometric specifications, it needs to be encapsulated by the right type of epoxy. By using customized folding jigs, MA's solution ensures a consistent final folded geometry for variety of PCBs and epoxy types, taking into account the material properties (shrinkage etc..) and the environmental conditions. As a result of this, MAFold cell can provide a complete solution in a small 1.5m x 1.6m footprint that can be deployed as a semi-automated island or integrated into a fully automated production line.



MAFold Cell

The Cell consists of a precise dispenser mounted on a pre-programmed 3 axis gantry with an integrated folding actuator assembly below the surface. The operator manually mounts the flat (unfolded) PCBA onto a jig and inserts this onto the conveyor within the cell. The supply of epoxy is then dispensed over the desired areas with an accuracy of ± 1%. Using low viscosity epoxies, the epoxy spread settles and evens out quickly. For redundancy, optional height check sensors or vision inspection cameras can confirm the desired spread geometry. Next, the folding mechanism automatically folds the jig and PCBA together to form its final geometry. The jig then exits from the cell conveyor to either a linked inline reflow oven or an operator who cures it in an industrial oven. While being held within the jig, this curing process locks in the required geometry of the folded PCBA. For an example of an 80x20mm encapsulation area, the cycle times for the MAFold Cell can reach 13 seconds or less.

Typical cell specifications:

Cell Dimensions (W x H x D)	1500 x 2200 x 1600 mm
Axis range	945 x 870 x 200 mm
Axis speed	0.5 m/s
2k Mixing ratio	1:1 to 10:1
HMI	Coloured Touch panel
Dispensing volume	Dosing quantities as low as to 0.005 ml (dependent on material)

References:

1. Lall, Pradeep, Jang, Hyesoo, Leever, Ben, and Miller, Scott. "Folding-Reliability of Flexible Electronics in Wearable Applications." Proceedings of the ASME 2019 International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems. ASME 2019 International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems. Anaheim, California, USA. October 7–9, 2019. V001T04A008. ASME.
2. George ElKoura and Karan Singh. “Handrix: Animating the Human Hand.” SIGGRAPH Symposium on Computer Animation (2003)