



Laser Ribbon Bond Loop Shape Prediction and Optimization

J. Michael Gray¹, Robert Shimpa²

¹Neuromodulation Pump Development, ²CRDM Device Mechanical Engineering

Challenge: Design reliable and robust Laser Ribbon Bond (LRB) loops for new devices without undergoing costly and time consuming “build-and-test” iterations.

Background: LRB is a process that is used at Medtronic to make internal electrical interconnections on most pacemakers (IPGs), defibrillators (ICDs), insertable loop recorders (ILRs), and neurostimulators (INSSs). The capability of the LRB process is highly dependent on the specifics of the design which makes it particularly important to understand interactions between the LRB process and design early enough so that changes can be made if needed to ensure high manufacturability.

Approach: Collaborate with the Institute of Mathematics and its Applications (IMA) at the University of Minnesota to develop a mathematical model that can accurately predict the shape of an LRB loop. Specifically this encompassed:

- Identifying key design and process inputs and creating a Design of Experiment (DOE)
- Building the LRB loops per the DOE and measuring loops with a optical coordinate measuring machine (CMM)
- Using data to create mathematical model that not only predicts loop shape, but associate the shape to meaningful metrics for reliability and manufacturability (e.g. curvature, loop length, etc.)
- Adding to mathematical model the ability to ensure design and process constraints are not violated (i.e. automated LRB Design Rules check)
- Automating mathematical model (via Excel) to enable loop shape optimization against key parameters like loop length, loop height, and loop curvature and resultant impact on reliability and manufacturability
- Running Monte Carlo simulations (via VisVSA) to predict impact of component and assembly process variability (e.g. step and span variation).

Results: A fully automated mathematical model was created and checked to within ~10% accuracy versus data from the LRB process characterization study for an IPG currently in development. This model was also used on an ICD project to successfully design 6 geometrically distinct LRB loops and assess their reliability and manufacturing robustness to component and assembly process variability without building and testing any actual loops.

Conclusion: Costly and schedule-consuming activities such as prototyping and iterative “build-and-test” experiments that previously were required to achieve a manufacturable design can now be avoided. The steps that were used for the LRB Shape Predictor and Optimizer can and should be used for other critical processes throughout Medtronic.

