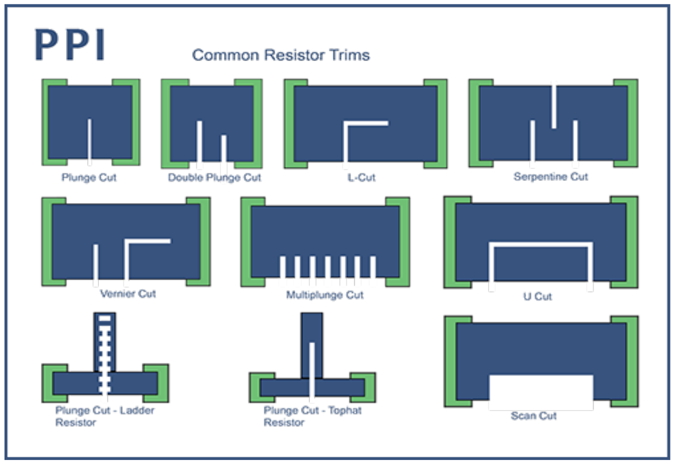
PPI

Advanced laser solutions for electronic and component production.

RapiTrim Solutions

Comparison of Trim Types

There is a variety of cut or trim types used to laser trim resistors. Each has benefits and limitations, and is chosen with the application requirement, production rate, cost and intended tolerance in mind. In general the comments below are applicable to both thin and thick film resistors, using any laser wavelength or spot size. Combinations of these trim types are also employed.



Single Plunge

A single plunge is the most basic cut, providing the highest speed due to its simplicity. While sufficient for many DC applications it has limited tolerance capability since for a constant bite size the resistance change is exponential with each added bite. The pre-trimmed value should be 50-80% of the final target desired.

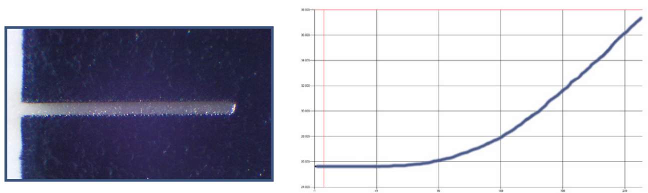


Photo of single plunge and its trim profile.

Double Plunge

To overcome the tolerance problem with single plunges, the initial cut can be set to stop before target (e.g. 95%). A second plunge is then added to approach target at a lower rate. While obviously slower than a single plunge due to this extra step, the benefit is the improved tolerance achievable.

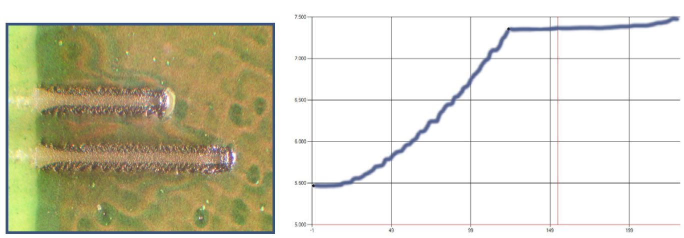


Photo of a double plunge and its trim profile.

L-cut

This is a variant of the double plunge in which the second leg starts at the end of the first leg and proceeds parallel to the current path. Again this improves the tolerance achievable compared with the single plunge. A short first leg and long second leg is usually preferred and the approach to target is quite linear. As with the single plunge, pre-trim values should be 50-80% of the trim target.

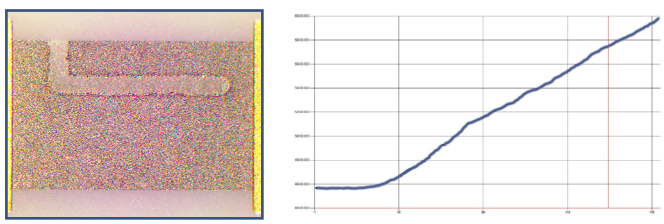


Photo of an L-cut and its trim profile.

Serpentine

This is formed by many alternating plunges into the trim region, forcing the current to meander around these barriers. The resistance can be changed from pre-trim values by a large amount (10X or even 20X is possible) with this cut type by adding more cuts or increasing the cut lengths. While the cuts can be placed anywhere, even spacing is usually chosen. Given the number of cuts to be made, the speed is significantly slower than single plunges or L-cuts. Due to the meanders this cut is only recommended for DC applications.

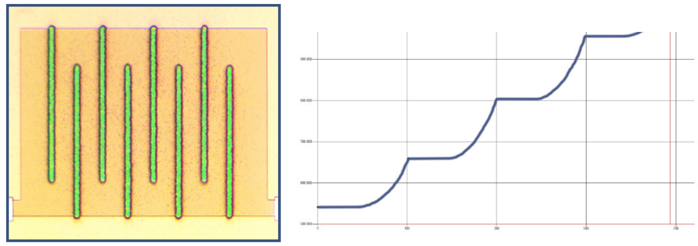


Photo of a serpentine trim in thin film material on a semiconductor wafer. The trim profile is from a 3-legged serpentine followed by an L-cut.

Shave or Scan Cut

These cuts are made by repeated scans along the length of the resistor (the direction of current flow) starting at the edge of the resistor and moving in with each successive scan line. Frequently the requirement is for both sides to be trimmed as equally as possible (a symmetric trim) but if just one edge is trimmed it's an asymmetric trim. Control over the pitch between scan lines in addition to the bite size along the laser path allows very fine control of the approach to target. High accuracies can be achieved, but obviously at the expense of speed. Symmetric shaves are often used for high frequency applications.

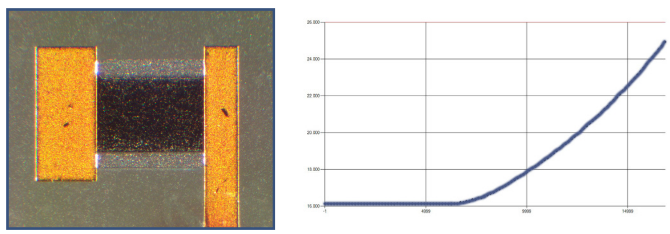


Photo of a symmetric shave trim in thin film material, and the trim profile.

U-cut

The L-cut can have a final leg that exits the resistor, forming a U-cut. The resulting resistor is similar to an asymmetric scan. The PPI software allows the corners to be rounded more than just by spot radius if required.

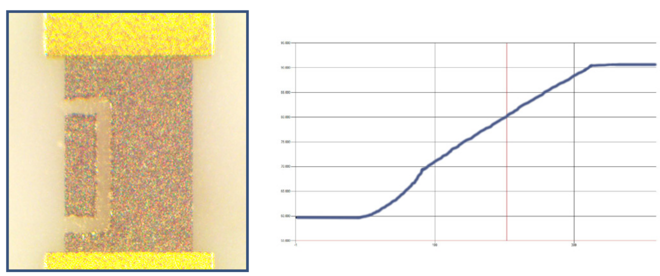


Photo of a U-cut in thin film material and a representative trim profile.

Ladder and Plunge

This combination cut is very versatile. Cutting the ladder rungs forces the current to a longer path, increasing the resistance. When the ladder cuts achieve their set target, the trimming switches to the top-hat resistor where a plunge cut it made to the final target. Top hat plunges are also used on their own without the ladder rungs.

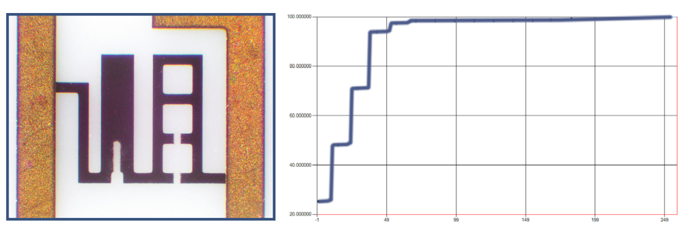
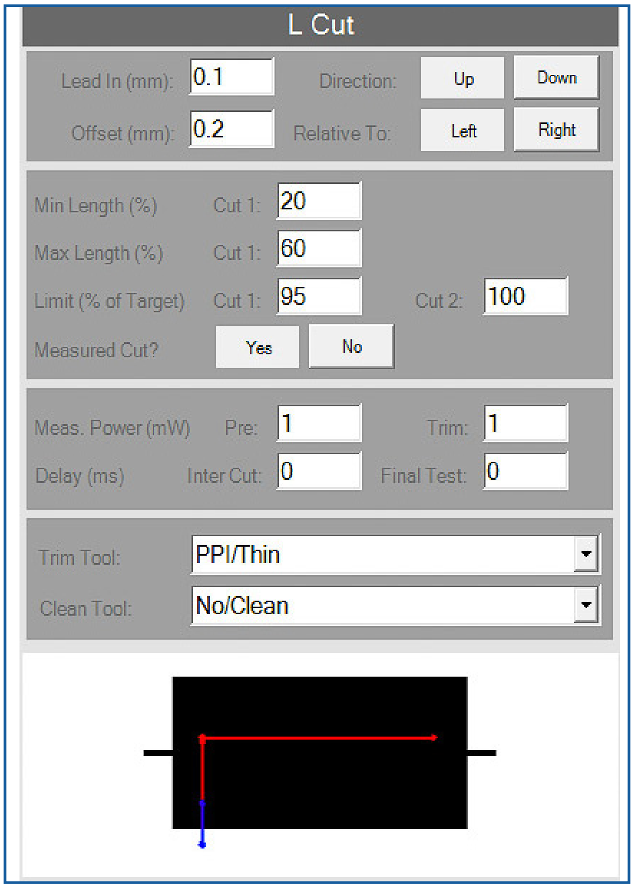
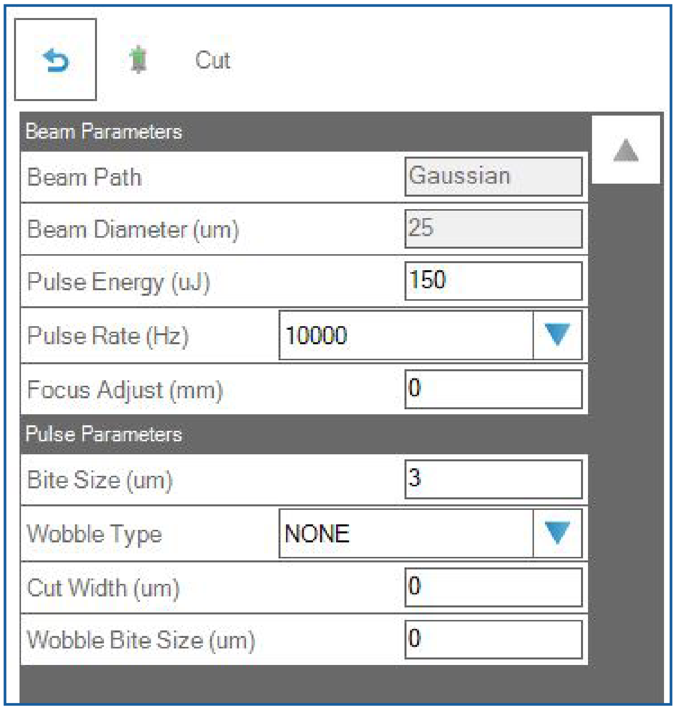


Photo of ladder and plunge trims in thin film material and a representative trim profile.



Trim tool for an L-cut showing representative parameters.



Laser tool for a simple plunge in thick film showing representatvie parameters.

Trim Tool Editor

Not all trim types need the same parameter control. As a result, specific screens are present to modify the parameters required for the different trim types. Here is an example of the parameters available to control an L-cut. There is a Library for storage of these tools.

Laser Performance

Whatever trim type is used, the chosen laser parameters can also have an effect on the speed, accuracy and quality of the results.

The laser spot size is set at the factory through proper selection of the beam conditioning optics. For thick film work spot sizes in the range 20-50µm diameter are typical. While similar can be used for thin film, work on small geometries (e.g. on semiconductor wafers) may require spots of 10µm or less.

The two other basic laser parameters are the pulse energy and the laser repetition rate. These are independently adjustable with modern fibre or DPSS lasers, a huge benefit compared to old lamp-pumped lasers in which these parameters and the spot size could interact in frustrating ways.

The pulse energy needs to be comfortably above the ablation or vaporization threshold to achieve consistent results, but not so high as to unduly damage the substrate. PPI provides a production-worthy process window.

The bite size (movement of the beam between pulses) is a settable parameter for making the laser cut. A smaller bite size (greater beam overlap) leads to a smoother cut edge, but a necessarily slower cut for a given laser repetition rate.

A relatively large amount of debris can be generated with thick film resistor trims, and some of this can fall back into the cut. A cleaning pass can be set to process automatically, retracing the beam path used for the trim but at lower energy to only remove this debris without substrate damage or resistance change.

Similar to the Trim Library there is a Laser Tool Library to store the sets of laser parameters that have been found to be optimum for the different trim types and materials.

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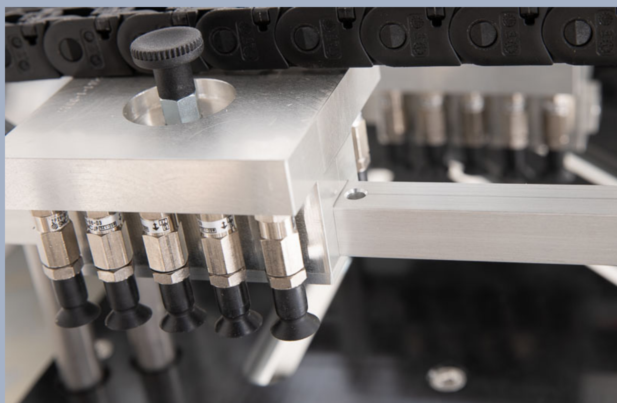
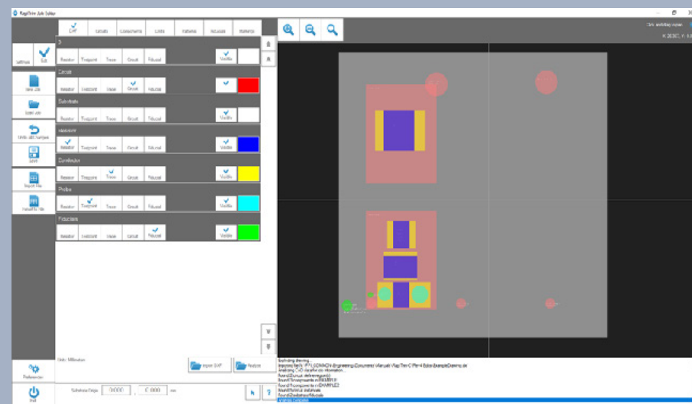
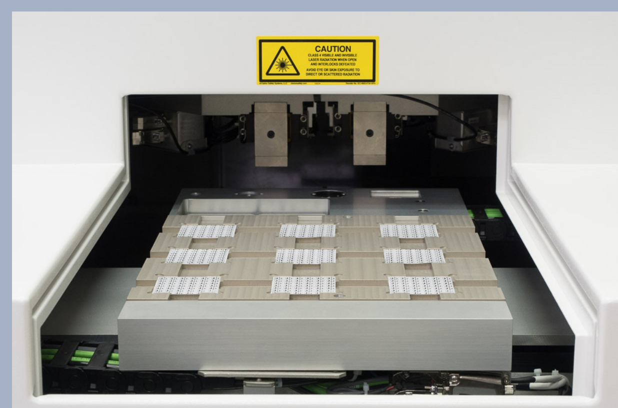


Pickup head for the optional stack loader.



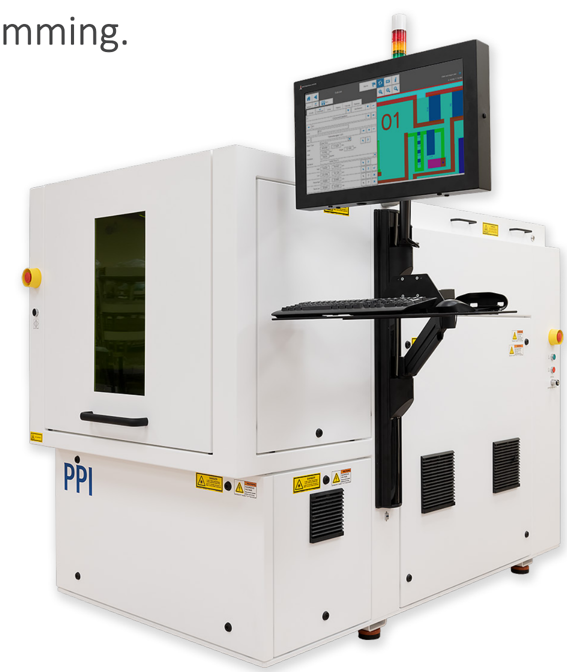
Streamlined job editing with the DXF auto-import function.

Probing arrangement for fuel gauge sensor.



Custom fixture for a 3x3 array of substrates.

RapiTrim is The Future of Resistor Trimming.



Summary

RapiTrim's fixtureless technology using four independent flying probes is ideal for quick-turn, high-mix production, allowing dense, complex circuit layouts to be trimmed as easily as simple designs. The probe card configuration is appropriate for the highest volume applications with less frequent job changeover. PPI staff are available to help you make the choice.

A complete family of RapiTrim products is available with different wavelengths. Options include stack loaders, custom fixturing, the SM200 switching matrix, active (functional) trim capability, external instrument support, bar-code readers and process sequence customization.

PPI provides turnkey solutions for all trimming needs, from standard component and circuit trim to complex active-trim scenarios with custom fixturing.