RapiTrim Solutions

Temperature Sensors

The RapiTrim family of resistor trimming systems can be delivered in a variety of configurations suited to different applications. The flying probe version is ideally suited to high-mix, quick-turn production. The probe card version is more appropriate for high volume production of only a few part layouts. Both system configurations can be of use in the manufacture of temperature sensors.

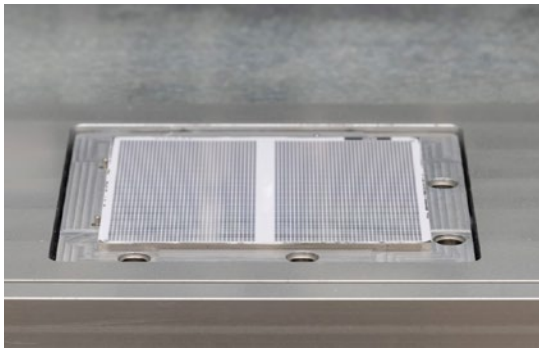
The sensors discussed here are Resistance Temperature Detectors (RTDs), based on the principle that the electrical resistance of a conductor increases with increasing temperature. Due to the large available temperature range and chemical inertness of platinum (Pt), it has long been the conductor of choice. The standard devices have a resistance of 100Ω at 0°C, with 1000Ω also used for lower power consumption and therefore less influence of self-heating by the current flow.

These devices have a wide variety of uses including automotive (temperature monitoring of the engine, air intake, coolant, transmission fluid, etc.) consumer electronics, power circuits, food processing equipment, industrial and medical electronics as well as military and aerospace applications. RTDs made with thin films of Pt on alumina substrates are quite stable and can be laser trimmed to very tight tolerances.

Substrate Layout

Individual sensors (die) vary considerably in size, from less than 1x1mm up to 7mm long. For most efficient manufacture the substrate size is 100 x 100 mm (4 x 4 inches), usually high purity alumina. The die count can then be anywhere between a few hundred per substrate to over 10,000.

A typical circuit pattern is comprised of one or more sets of fine lines with ladder rungs (short circuit bridges) to be cut for stepwise coarse adjustment of resistance. This is followed by a final plunge cut to target in a top-hat style resistor. The Pt traces to be cut can be 10µm or less in width, separated by as little as 30µm, requiring a small laser spot and high placement accuracy.



Substrate with array of RTDs on the temperature-controlled vacuum chuck.

Laser and Beam Delivery

While the 1.06µm wavelength from the standard fiber laser is capable of removing the Pt films, the green laser wavelength at 532nm is more often the choice. Green operation not only provides clean removal of the Pt films but with a small spot (10-15µm) for greater precision and a larger depth of focus for a more relaxed operational Z tolerance. The small spot is consistent across the 25 x 25 mm process field and all devices falling within this area are processed before re-positioning the substrate with the XY stages.

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Part fixturing and temperature control.

Substrates are held in location on a vacuum chuck, with the vacuum on/off controlled by the program. The flatness of the chuck is mapped over its working surface and all Z motions are automatically adjusted for height variations depending on the location on the fixture being probed / trimmed. If the substrate itself has a severe camber / wedge then an initial autofocus routine can be used to map this height variation and again enable compensation of the beam focus while processing different regions of the substrate. This is an essential feature of systems using these small laser spots with the accompanying shallow depths of focus.

The RapiTrim RTD solution includes temperature measurement and active temperature control of regions of the chuck, allowing a simple script to calculate new trim targets based on the measured temperature. This enables the manufacture of more accurate devices.

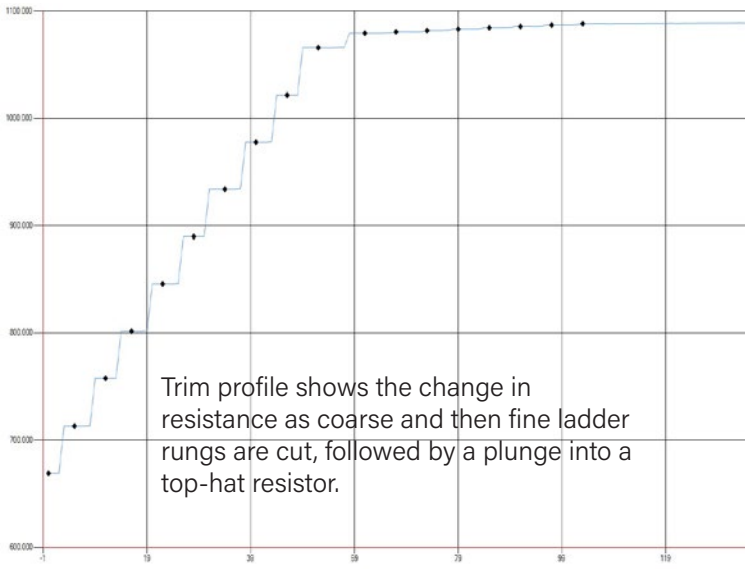
Probing and measurement options.

Both flying probes and probe cards can be used in this application. PPI can help the customer assess which of these techniques is the better fit for their requirements. If high accuracy is required, Kelvin probing is available with either probing technique.

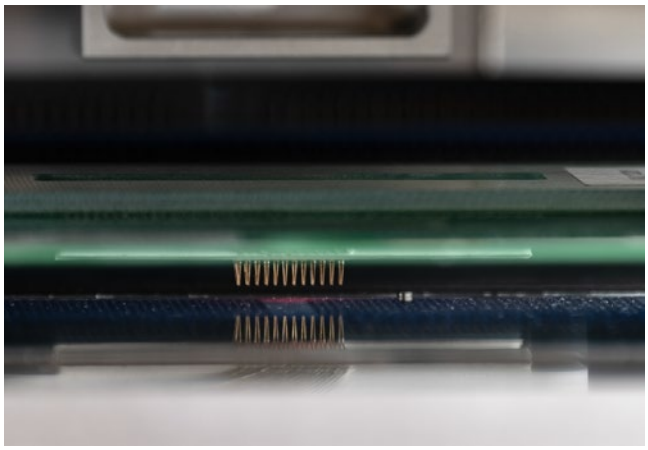
With probe cards, the set of probe tips can be adequate to measure just one DUT, or can have multiple sets of probe tips to simultaneously contact many DUTs within the laser process field, which are then sequentially accessed by the switch matrix.

The four independent source-measure units in the RapiTrim are each capable of providing Force, Sense, and Guard signals. Alternatively, the switch matrix can route signals from either the flying probes or probe cards to external instrumentation (e.g. a high-accuracy DMM), integrated into the RapiTrim job. The instruments themselves are located in an equipment rack within the machine enclosure.

Since the real-time measurement in the RapiTrim can record the resistance change with each laser pulse, a Trim Profile can be output. Customers have found this invaluable during process development, allowing the best combination of throughput and accuracy to be implemented in production.



Trim profile shows the change in resistance as coarse and then fine ladder rungs are cut, followed by a plunge into a top-hat resistor.



Probe card with a set of Kelvin needles for contact with several devices at the same time.

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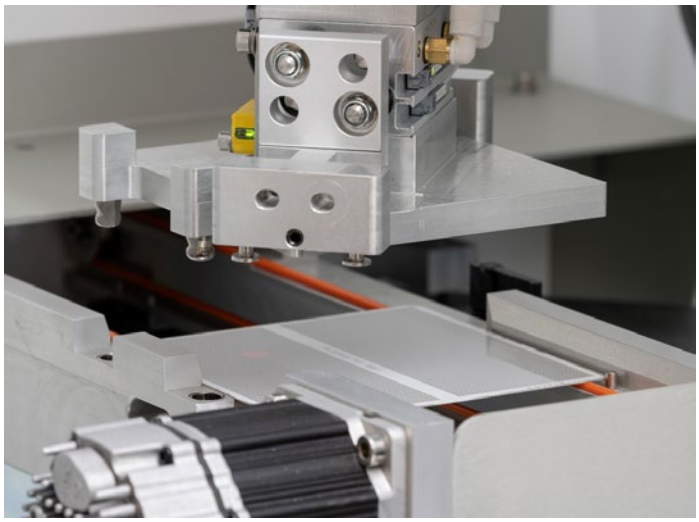
Automation options.

While individual substrates can be loaded manually, the high-volume manufacture of RTDs requires the efficiency of automation. The delicacy of the Pt traces prohibits contact with the top (active) surface, leading to the use of magazines for transporting substrates around the factory.

Again, due to the sensitive active surface, vacuum pickup is replaced with edge grippers as shown here. The width of the infeed and outfeed conveyors and the gripper jaws are adjustable for a range of substrate sizes.

If substrates are handled in magazines throughout the manufacturing process, the RapiTrim can be integrated with magazine handlers using the SMEMA interface. Internal to the machine one robot picks a substrate from the load conveyor and places it on the vacuum chuck, and a second robot performs the unload task. This arrangement provides hours of uninterrupted processing, requiring only the addition of fresh magazines on the load side and removal of processed magazines on the unload side. Excluding the magazine loaders allows this design to be compatible with conveyorized integration.



Substrate on conveyor at the load position with robotic pickup head above.

Job creation.

The main job can be created simply by importing a DXF with the design of the device, layout of the substrate, and fiducial locations. If calculation is required for a revised trim target based on the measured temperature of the chuck, this can be accomplished through a script that will operate within the RapiTrim job. Similarly for the seamless integration of a measurement by an external DMM or other instrument. The ProSys™ user interface combines a simple clean layout with useful features to both streamline process development and provide efficient high-volume production.

PPI has your solution for RTD production.

RapiTrim

The Future of Resistor Trimming™

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