Automated Assembly Tool for Precision, High-Speed
RF Die Attach Applications

A fully automatic assembly tool for high-frequency
RF power amplifier integrated circuits

Palomar Technologies, Inc.
2728 Loker Ave. West, Carlsbad, CA 92010
Main: 760-931-3600 | Fax: 760-931-5191
www.palomartechnologies.com

As telecommunications and information processing have exploded over the several decades, the need for extremely accurate, high-yield microchip assembly solutions has shifted from a low volume aerospace and defense industry niche to a broad, high volume commercial market encompassing multiple industries. From palmtops to telecommunication switches, the chip industry is witnessing an insatiable requirement for more and more accurate devices at ever increasing and more cost-effective production rates.

The keys to responding to this challenge are improved hardware and software to enable greater speeds without sacrificing precision, increased automation to eliminate error-prone human handling during processing, and greater integration to create a seamless, integrated assembly platform -- complete process solutions coupled with agile automation.

To address these needs, a new, world-class, RF precision assembly machine has been developed to specifically support the RF power amplifier component assembly manufacturers. The Palomar Technologies die attach system HotRail™ RFA (RF assembly) cell is a fully automatic, high accuracy (±10 µm) piece of equipment that provides heat profile vs. time eutectic reflow at the build site.

The die attach machine utilizes a general purpose optical workbench platform with command and I/O-rich programming to accommodate virtually any combination of material presentation devices for assembly automation. These component presentations include waffle pack, gel pack, tape and reel, and expanded wafer configurations. Two- and four-inch waffle and gel packs may be utilized. Wafers from three to eight inch can be accommodated, with multiple wafer presentation available (1-up, 2-up, 4-up and 6-up).

An advanced positioning system, utilizing the company's patented digital servo control system, provides the capability for trajectory-driven, position-controlled sub-micron resolution in each of the machine's axes. An x-y cantilever boom arm carries a compound bond head (z and θ axes). The range of the x-axis is 35.5", y-axis is 20", z-axis is 2" and θ axes is >360°.

An advanced temperature-profiling device and method eliminate eutectic control inconsistencies common in today's die-attach methods, and provides programmability for increased yield and throughput. RF headers are conveyed through a ramped temperature gradient that gradually brings the packages to the eutectic reflow temperature. After chip placement, the packages are conveyed out of the placement area and gradually returned to ambient temperature. Temperature of the preheat, eutectic and cool-down zones, as shown in Figure 1, are independently programmable.
The HotRail RFA enables the RF component manufacturer to achieve precision side-by-side placement of die for subsequent wire bonding of consistent wire loop profiles. Repeatable wire loop profiles are essential for meeting high frequency, RF device impedance specifications. The new RF component assembly cell provides precision juxtaposition of die with steady-state heat eutectic processing, resulting in consistent wire loop bonding profiles from bond to bond. Figure 2 shows the HotRail system's cartesian X-Y placement head, eutectic processor, die ejectors and output handler.
**HotRail Benefits**
There are many benefits derived from using the HotRail RFA. These advantages include quick and easy vacuum tool changeover for a wide range of parts and die during production. Up to eight eutectic collet or conical tip vacuum bond tools may be mounted and pre-calibrated in the bond head. Tools are changed "on the fly," speeding up assembly of multi-chip devices and eliminating the need for a space-consuming tool dock. This capability helps maximize production speed and yield over time. Careful handling of fragile parts and die is achieved via programmable force (10 to 400 grams in 1 gram increments), programmable approach speed and deceleration, and programmable over-travel (in 0.1 mil increments). This helps to maximize product yield and performance, and minimize loss due to broken or impaired parts.

**Configuration Examples**
The HotRail RFA features a ready-to-go, eight-position turret head. The key to fast, precise assembly is its ability to pre-align, calibrate and program all tool axes, including *, for up to eight vacuum tools on the turret head.

For large component handling, components greater than two square inches can be transferred from the input tray to the eutectic heater stage for assembly. For example, a custom-made vacuum tool can pick a 0.4" x 0.4", 0.2 oz. flanged header.

Exceptionally small and delicate components can be picked from waffle or gel packs, tape-and-reel feeders, wafer die ejectors and other forms of presentation. Minimum die size is 7.0 x 7.0 mils. The machine's pattern recognition capability allows a high degree of die divergence and rotation from the basic presentation pattern.

**Eutectic Processing**
Transfer and scrub parameters are programmed and the temperature is set to achieve optimal placement, adhesion and alloy results. The header is heated and held to a set temperature for the duration of the eutectic assembly process. Preheat mesas or HotRails are available for faster part presentation.

Nitrogen cover gas is applied to the reflow area for purification of the bonding area. Each die in the assembly sequence is transferred and scrubbed into place.

**Conclusion**
A eutectic die attach machine has been described that provides high precision, high reliability placement of components to meet today's high volume, low cost chip assembly requirements. The HotRail RF component assembly cell is a fully automatic assembly tool for the support of manufacturers of high frequency RF power amplifier integrated circuits. Its versatility and ease of use can lower cost and improve performance of assembling RFIC devices.