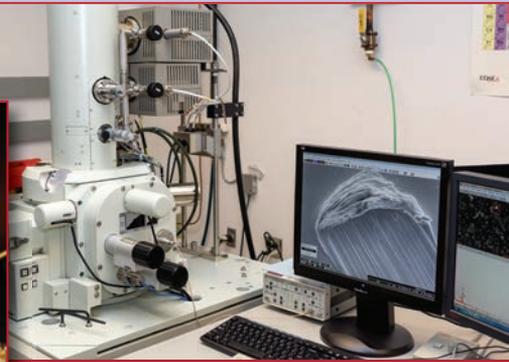
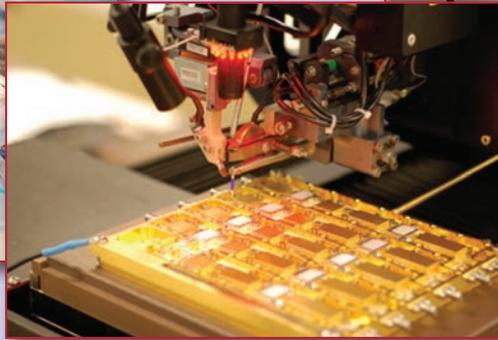


# FAB S and LAB S

## Ahead of What's Possible: ADI's Hybrid Module Manufacturing Center



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When Yalcin Ayasli left Raytheon to form Hittite Microwave in 1985, the market for microwave components was military, and GaAs MMICs were still a nascent technology. Ayasli built the small company one MMIC at a time. As the fabless semiconductor firm grew, designers expanded from GaAs to other semiconductor technologies, and Hittite built an enviable catalog of products for virtually all the RF functions in a typical block diagram. With such a large portfolio, from RF to millimeter wave, Hittite's designers found they could combine their MMICs into multifunction modules to solve many of the challenges facing defense systems. As the military community is understandably discreet, only those involved in such programs knew of the formidable module capabilities Hittite was developing. In 2014, Analog Devices (ADI) bought Hittite Microwave to accelerate growth and extend its portfolio from bits to millimeter wave. ADI quickly embraced Hittite's module capability and began expanding its reach.

Bryan Goldstein joined Hittite in 2003 and is now responsible for all of ADI's defense and space business and growth. With the enthusiasm of a proud inventor, he and Everett Cole, the director of the hybrid module manufacturing center, escort MWJ around an unassuming, DoD cleared building in Chelmsford, Mass. The facility occupies 72,000 square feet, of which 20,000 is clean room, and contains all manufacturing steps from incoming to shipment. In an average year, the operation will produce 10,000 integrated modules, 600 subsystems and 250 integrated systems — not high volume compared to mobile phones, yet very impressive considering the complexity, performance and reliability of the products, some of which fly in space.

The core of ADI's value proposition is their ability to build a subsystem using their own MMICs. Drawing from an extensive catalog of devices, they can trade component performance in the block diagram to optimize system perfor-

mance. While simulating designs before building hardware is now common design practice, ADI is uniquely able to take the next step: quickly building a breadboard by pulling MMICs and evaluation boards from stock. Goldstein says the company's ability to provide measured data is a tremendous advantage when submitting a proposal.

ADI's manufacturing capabilities are extensive: five on-wafer probes characterize devices to 110 GHz and over temperature. Four wafer pick machines pull the good die and can bin them to sort performance. ADI employs both human and automated visual inspection, the choice depending on program requirements. Module assembly capabilities comprise vacuum reflow eutectic and automated epoxy processes for die attach, followed by ball, wedge and ribbon bonding. For space applications, the wire bonders also perform pull testing. As many high reliability applications require hermetic sealing, the facility has laser weld, seam, solder reflow and DAP sealing, as well as leak testing.

All environmental stress screening is performed in-house, including burn-in, temperature cycling, vibration, shock and high G centrifuge. The quality management system is AS9100 certified, with quality assurance and failure analysis capabilities that include real-time X-ray and scanning acoustic and scanning electron microscopes. Automated module test spans all microwave functions, including high power amplifiers, up- and down-converters and low phase noise synthesizers. With systems extending from RF to bits, test capabilities encompass the digital interfaces.

Over the years, ADI's module capability was marketed program by program, customer by customer. Bryan Goldstein wants to change that. "I want all aerospace and defense systems designers to know that we can help them develop the most advanced systems with faster time-to-market and higher ROI. We do this by providing the broadest portfolio of component and system level solutions. ADI provides solutions from the antenna to bits and from the semiconductor to the integrated subsystem. That is a true differentiator."