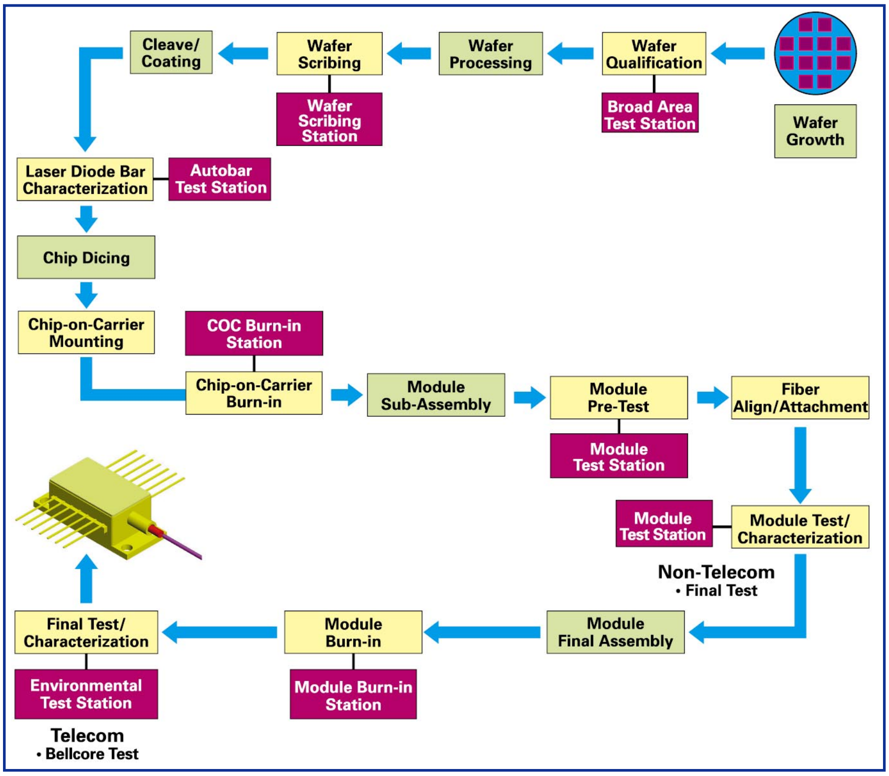
Laser Diode Controllers

Coming soon: tighter control, more integration and higher current.



Laser diode controller requirements are increasing as manufacturers test new devices more quickly and at more test stations.

The demand for high-precision laser diode components has skyrocketed with the rapid growth of optical networks using dense wavelength division multiplexing technology that requires many transmission lasers and pump lasers. This explosion in demand and the consequent shortage in commercially available laser diodes has increased the pressure on manufacturers to ramp up production volumes quickly by increasing yields of devices that are within the desired specifications.

To make devices cost-efficiently and to facilitate process-control improvements, manufacturers are testing laser diodes after every major step of the production cycle. Full testing requires electro-optical, spectral and spatial characterization at different temperatures using both laser diode controllers and test instrumentation. Because a laser diode's output is a function of its bias current and temperature, diode controllers must tightly control these parameters while preventing damage from voltage and current fluctuations and transients.

For the initial broad-area wafer and laser diode bar testing stages, before the devices have been bonded onto heat sinks, the laser diode controllers use drivers that inject low-duty-cycle pulsed current at fairly high levels (1 to 3 A). After the chip-on-carrier mount stage, fixtures or mounts electrically connect the laser diodes and controllers. At this stage, the controllers include standard drivers that are low-noise, constant-current sources and temperature controllers to govern the thermoelectric cooler that regulates temperature.

Volume demands

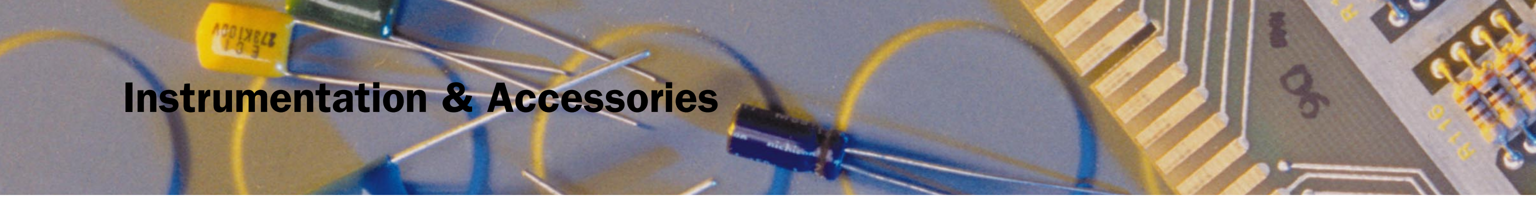
High-volume production increasingly requires one instrument that integrates photodiode or pyroelectric detectors, diode driver/cooler control electronics and fixtures that accommodate 16 to 32 chip-on-carrier or butterfly/coaxial devices, for use with test equipment such as spectrum analyzers and power meters. Ideally, manufacturers want completely integrated solutions that combine laser diode controllers, test instrumentation, fixtures, mounts, motion controllers and report-generation software in a turnkey, automated test system.

Whether it is a burn-in application that requires several hundred hours or high-speed Bellcore characterization of the final device, there is a growing need for systems that can simultaneously test 256 or 512 devices. Whereas benchtop instrumentation can control eight to 16 modules, these high-density systems typically include miniaturized control modules mounted on one printed circuit board that can control 32 to 64 devices. Although current technology can control and test 512 devices with 12-bit precision, the state of the art is bound to advance quickly to accommodate higher densities at 16- to 18-bit precision.

There is also a strong drive for more automation during manufacturing to lower device cost and damage caused by operator part handling. Fully automated manufacturing technology incorporating palletized loading/unloading of parts and robotic pick/release between test stations should emerge within 12 to 15 months. This should prompt innovations in the design of the probes/fixtures that connect the devices to the laser diode controllers.

Need more power

New laser diode technologies are constantly driving the current and voltage requirements of diode controllers. As pump laser power levels have escalated every year, laser diode



controller current requirements have risen beyond levels that were unimaginable a few years ago. New vertical-cavity surface-emitting lasers, electroabsorption-modulated lasers and multistage tunable laser technologies are also compelling innovations in controller voltage-handling capabilities.

In very high power noncommunications applications, other expected innovations in laser diode controller design include tunable power supplies, use of quasi-continuous-wave modes and currents in the 250- to 300-A range.

In addition, as manufacturers strive for shorter cycle times with accelerated lifetime testing, the temperature range over which laser diodes have to be characterized will increase from 75 to 85 °C to more than 100 to 150 °C.

If laser diode manufacturers are to achieve large-scale cost reductions similar to those attained in the semiconductor industry, they will have to design for automated manufacturability and work with competitors and suppliers to standardize package and process design. As this scenario comes to fruition within the next three to five years, this will further drive other innovations in laser diode controller technology. □

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