Pulse testing 980-nm pump laser diodes in optical fiber amplifiers

HEWLETT PACKARD

Application Note 1268

Optical-fiber amplifiers help solve the bandwidth and attenuation problems of long-haul fiber links. Current research on erbium-doped fiber amplifiers -- which were first unveiled in 1987 -- promises improved reliability at lower cost, paving the way for economical broadband integrated services needed for the growing demand for communications services such as video-on-demand, home banking, teleconferencing, etc.

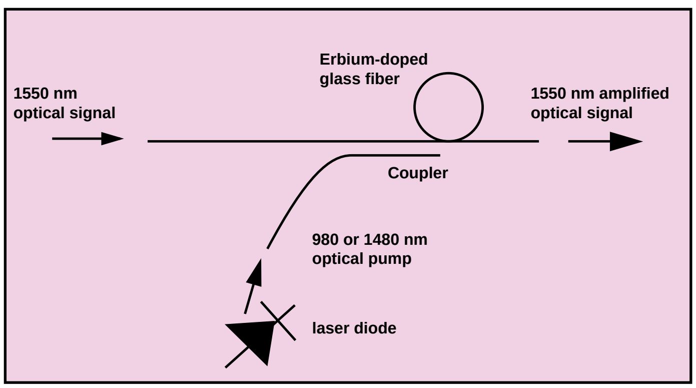

Figure 1: Block diagram of a fiber amplifier

An essential accessory of the fiber amplifier is a pump source. This provides the energy for the amplifier itself which consists of several meters of glass-fiber whose core is doped with erbium. The erbium atoms are pumped through their absorption bands at 980 or 1480 nm, imparting energy to the incoming optical signal.

At the recent European Conference on Optical Communications, it was suggested there could be a trend away from the more established 1480 nm semiconductor laser pumps in favor of 980 nm ones because of higher efficiency and lower noise. Some types are also less sensitive to temperature, eliminating the need for costly external cooling and show a reliability that could be as good or better than the 1480 nm lasers.

To gain better understanding of laser-diode pumps, Norwegian Telecom's Research Institute at Kjeller near Oslo fabricates and tests semiconductor lasers. Measurements are made under pulsed conditions so that the lasers can be tested unmounted and without any heatsinking. A low duty cycle assures negligible warming so that the device is neither damaged nor do its properties change. This way, individual diodes can be evaluated while they are still on the wafer.

Although the diodes are driven by a dc in the target application, pulsed measurements are an accepted standard method of characterization.

The measurements are performed using a pulse source, an oscilloscope to monitor the input current, and an optical power meter (see Figure 2). The instruments are computer-contolled via HP-IB. As also indicated in Figure 3, separate probes are used for supplying current and monitoring voltage of a particular laser on the bar.

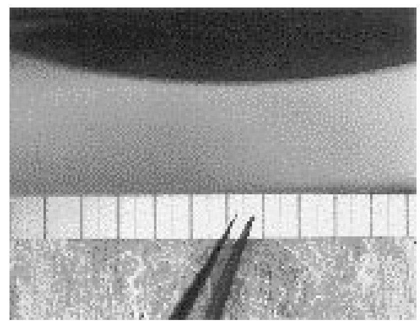

Figure 3: Probe details

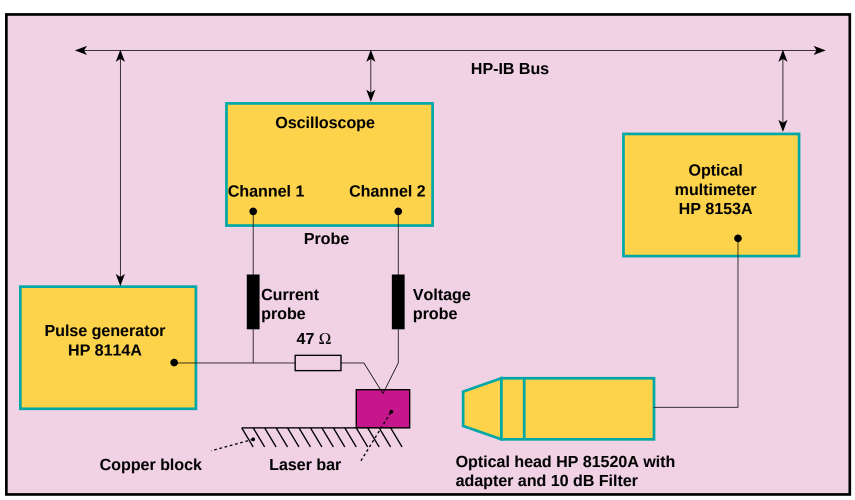

Figure 2: Test setup

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Figures 4 and 5 show the results of two measurements performed on the same laser diode -- an uncoated 980 nm ridge waveguide laser with 5 um ridge width and 600 um cavity length. The first plot in Figure 4 shows the average optical power output for a range of peak pulse currents from about 20 to 90 mA in 1 mA steps. The second plot shows the voltage across the diode for each value of current. An attenuator is necessary for the small pulse amplitudes needed by diodes with very low threshold currents.

Figure 5 shows the characteristics for higher currents. The laser diode is operated at currents up to 800 mA, an extremely high value for a narrow stripe laser, but a typical condition for a broadarea laser. In this case, the current is increased in 5 mA steps. The pulse generator allows the current to be programmed directly in terms of amps or mA.

The above results are typical of measurements done regularly, in which 1 us pulses at a rate of 1 kHz are often used. The form of the current pulse (Figure 6) through the diode -- obtained by matching the 50-ohm source resistance of the pulse generator to a load consisting of a 47-ohm resistor in series with the diode's forward resistance of about 3 ohm -- is good enough for this application although it could probably be further improved by making the probe needles and the leads to the 47-ohm resistor shorter. Another possibility would be to use the pulse generator's offset capability so that a small forward current exists between pulses. However, the offset current is, in contrast to the pulse current, created by a voltage source. This makes it difficult to control the exact base current through the diode. Another reason for not using a dc bias is that at least 10 mA would be needed to obtain a resistance less than 10 ohm, and this would heat the diode.

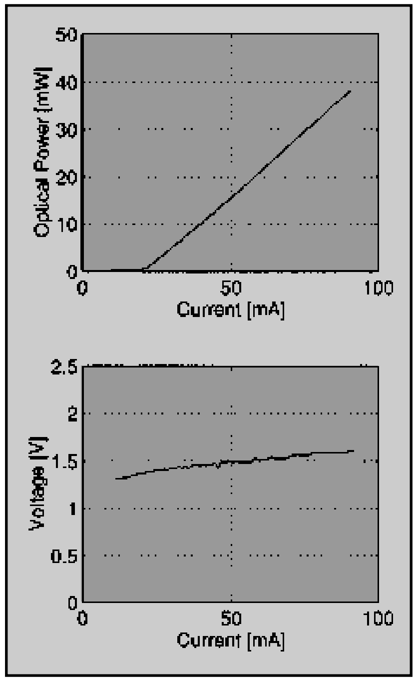

Figure 4: **Laser diode I/P and I/V characteristics I < 90 mA**
a) I/P characteristic
b) I/V characteristic

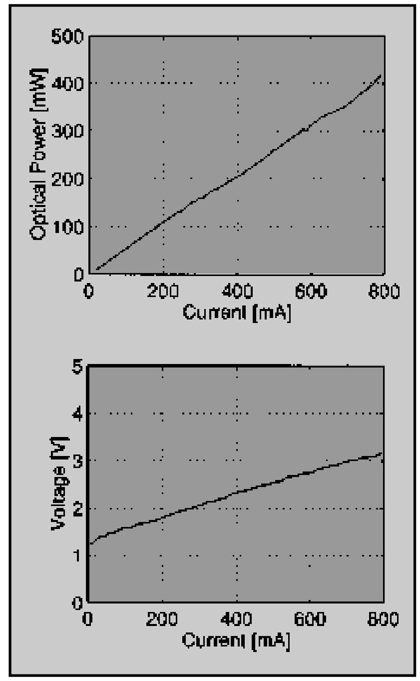

Figure 5: **Laser diode I/P and I/V characteristics I < 800 mA**
a) I/P characteristic
b) I/V characteristic

In conclusion, the pulse technique for unmounted diodes gives consistent results with dc measurements made on heatsinked devices. This has the advantage that measurements do not have to be performed on expensive finished products. The HP 8114A pulse generator's clean current pulse through the laser diode is one major contribution to this result. Another is the direct, accurate, programmability of the current.

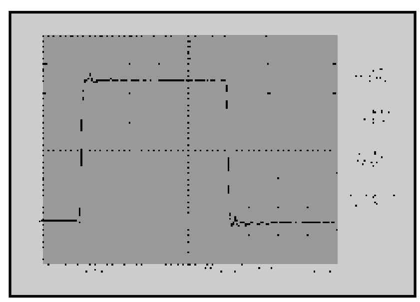

Figure 6: Diode current.

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