A Brief Update on Optical Technology and Applications

The optical communications market has been affected by the recent economic slump to a greater degree than most other areas of technology. Ironically, this is partly a result of its success—in response to a huge increase in the amount of data transmitted via optical backbone links, engineers have made breakthrough developments in transmission efficiency. Now, what was once thought to be a prudent amount of future capacity is a glut of bandwidth that will take years to fill. This is because engineers figured out how to dramatically increase the capacity of a single fiber, compared to existing technology at the time the fiber was installed.

Although this high-dollar part of the optical market is slow, there remains significant activity in high-speed systems (10 to 100 Gb/s). OC-192 (10 Gb/s) and OC-768 (100 Gb/s) systems are attractive for applications such as high definition television (HDTV), high-traffic systems such as travel reservations, and high throughput real-time applications such as air traffic control radar and fundamental physics research.

Sensors are another growing part of optical technology. Although applications directly related to high speed/high frequency electronics are few, there are some unique RF/microwave sensors, such as those used for measurements where the isolation of an optical fiber is required. In addition to sensors, new optical imaging applications require high-speed video processing and distribution circuitry.

Technical Issues

The now-classic signal integrity issues of high-speed digital signals in an analog medium apply to optical systems. In the electronic portion of a fiber optic communication system, these issues arise in the laser diode driver circuitry and in the phototransistor detector circuitry.

Both of these places in the signal chain must use new techniques for maintaining an accurate representation of a digital "1" or "0" within an analog circuit subject to losses, reflections, dispersion and radiation. In addition to signal path issues, high speed data transmission must have highly precise timing references with the ability to maintain low noise and jitter, excellent long-term stability and synchronization capability via GPS or an internal system synchronization signal.

The laser diode driver circuitry has the added challenge of driving a load that requires a significant amount of current and may not have a consistent impedance at all drive levels. To achieve the rise-time required for highly reliable detection of a digital signal, the frequency response must be at least five times higher than the repetition rate of the data, preferably seven times. Thus, for a 10 Gb/s system, a driver must have a bandwidth of 50 GHz. There are techniques for easing this requirement somewhat, including multi-carrier multiplexing that divides the main data stream in several lower-bit rate paths.

The detector's transimpedance amplifier must cope with the unusual microwave problem of high impedance. As we can infer from simple RC and R/L time constants, a larger "R" means that parasitic capacitance and inductance have a much larger effect than they would have at a lower impedance. To combat this problem, integration is used that shrinks the dimensions of the circuitry, minimizing the parasitics and reducing the distance between detector input and recovered data output.

Video Displays

Although not considered to be mainstream optical technology, displays are a rapidly growing area where high speed electronics and optics come together. HDTV has an analog bandwidth in the range of 25 MHz, which requires signal processing circuitry operating in the VHF range.

The higher-frequency internal signals make it more difficult for these new displays to meet the compliance standards of worldwide EMC regulations, which have much lower emission limits at VHF than at lower frequencies. Some users of flat-panel plasma displays have experienced this problem as interference to nearby wireless devices.

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