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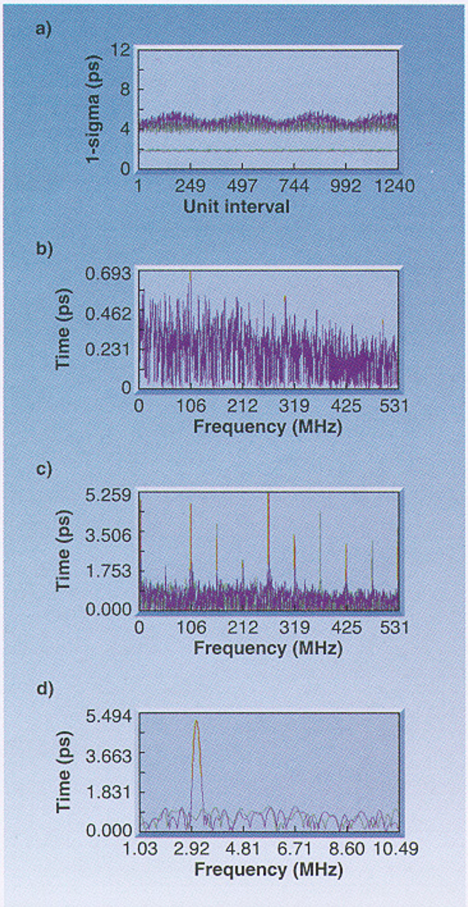
Jitter analysis seeks role in system design

As upward pressures on transmission speed and signal density increase in data communications, designers of Fibre Channel and Gigabit Ethernet systems are requiring more-precise characterization of semiconductor laser sources and optical communication systems. One area in which emerging technology may help to meet that need is in spectral analysis of the jitter components of serial clock lines and optical data signals.

Current test methodology for serial data communication in optical fiber does not analyze the spectrum of the jitter component, according to Dennis Petrich at Wavecrest Corp. (Edina, MN). Bit-error-rate testers and oscilloscope eye diagrams require a bit clock and basically look only at the initial clock data-transfer function. Traditional spectrum-analysis methods also bump into limits when measuring data signals. "You might see the spectrum and all of the risetime components, as well as the jitter component," he said. "You would need to look below the Nyquist [to isolate the jitter spectrum] using a spectrum analyzer."



Jitter spectrum analysis for high-performance data-communication systems can require a higher level of processing than is provided by standard bit-error-rate testing (BERT) or oscilloscope eye diagrams. The K28.5 signal pattern (Wavecrest DTS-277 Accumulated Time Analyzer) at 1.0625 Gbit/s is generated by an 850-nm diode-laser source. The 2-ps line represents BERT, the 4-ps line represents an optical test board, and the 5-ps line represents output of optical test board being fed by oscilloscope optical-electrical converter probe (a). In Fast Fourier transform of BERT output, peak-to-peak periodic jitter drops to 0.7 ps, and Gaussian noise floor drops to 1.8 ps rms (b). Fast-Fourier-transform overlay of BERT, oscilloscope, and optical test board signals shows increased amplitude in jitter spectrum peaks and jitter noise floor (c). Magnified view of left side of c shows 3.1-MHz spectral line with 5-ps amplitude, which originally appeared to increase deterministic jitter but was actually an artifact of the oscilloscope optical-to-digital converter probe (d). Unit interval is 941.2 ps for all data.

So a need has arisen for measurement equipment that will allow data-communication-system designers to analyze timing components for pumping variable-frequency data signals down multichannel optical links, Petrich said. And a first step in addressing these issues is to break down the jitter into different components, according to Michael Li, also at Wavecrest.

Classical analysis techniques use either peak-to-peak or root-mean-square area calculation methods to represent jitter, Li said. Using just the rms value, however, assumes that the jitter is a random process, and peak-to-peak alone assumes a deterministic process. In reality, both components are always present.

So Li and his colleagues have focused on separating the components and then using the appropriate measurement to describe each one. "Once you know the deterministic portion, you can use the peak-to-peak measurement to quantify it," he said. "And once you know the random portion, you can use the rms value to quantify it."

Approaches to separating jitter components published by Li, Petrich, and colleagues include a random signal-processing method based on slewed autocorrelation and a tail-fitting method that relies on a probability density function for a Gaussian model.[1,2] Systems based on these types of approaches can provide a breakdown of jitter into different components and give good insight into what is happening, in terms of dispersion interference and variation of optical index, within fiber communication or laser transmission, along with spectral information, Li said (see figure).

"Obtaining a spectrum in the time domain means that you measure jitter over a time series. And through traditional digital-signal processing you can transfer this information to the frequency domain," he said.

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REFERENCES

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2. J. Wilstrup, "A method of serial data jitter analysis using one-shot time interval measurements," *Proc. ITC* (1998).