A Single-Shot Network Analysis Method For The Characterization Of Opto-Electronic And Electrical Devices And Systems

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SUMMARY

UCLA researchers in the Department of Electrical Engineering have developed a single-shot network analysis method that can perform both time and frequency domain measurements of non-linear behavior of various optical or electrical devices and systems within significantly reduced test time.

BACKGROUND

A network analyzer measures the network parameters of active and passive components of optical and electrical devices. The ability to measure the input characteristics of each port, as well as the transfer characteristics between different ports of each component gives designers the knowledge to configure a component as part of a larger system.

There are two basic types of network analyzer: scalar network analyzer (SNA), which measures only amplitude-related properties; and vector network analyzer (VNA), which measures both amplitude- and phase-related properties. The growing demand for higher data bandwidth requires increase of the operating frequency of components and systems. It is challenging for conventional SNA and VNA, as well as time domain reflectometer (TDR) to perform accurate instrumentation and measurements of the various characteristics of electronic and optical devices or systems at high data bandwidth.

There are two types of high-performance digital oscilloscopes to reconstruct incoming signal digitally: real time (RT) oscilloscope digitizes the full wideband signal with high throughput at the cost of reduced resolution, limited bandwidth, massive energy consumption, larger footprint, and higher price; and equivalent time (ET) oscilloscope samples incoming repetitive signals at a rate significantly lower than the Nyquist, but can reconstruct repetitive signals by accumulating samples over many periods. ET oscilloscopes have excellent resolution, jitter performance, and high bandwidth capabilities, but are limited to analyzing repetitive signals with low throughput. ET oscilloscopes also require a synchronized clock and long data acquisition and analyzing time. It is also difficult and time-consuming for these analyzers to perform certain measurements such as non-linear system transfer function analysis.

Therefore, we need real-time wideband network analyzers that can perform measurements and modeling with both amplitude and phase, as well as in time domain over a wide frequency range within reasonable test time.

INNOVATION

Researchers at UCLA have developed a single-shot network analysis (SiNA) method, which uses photonic time-stretch technique to compress the signal bandwidth to a more manageable rate before digitization. Combining its real-time burst sampling modality based on time-stretch enhanced recording (TiSER) oscilloscope, this method can be used to study non-linear behavior of various optical or electrical devices and systems, as well as high-speed dynamics of high-speed circuits and systems.

APPLICATIONS

Allows for characterizing RF, microwave, and optical devices or systems

Allows for applications in:

- Wireless communication (i.e. base transceiver station, P2P communication, consumer electronics)

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INVENTORS

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OTHER INFORMATION

KEYWORDS

Network analyzer, single-shot network analyzer, photonic time-stretch, time-stretched enhanced recording (TiSER) oscilloscope, real-time burst sampling

CATEGORIZED AS

- **Communications**
  - Optical
  - Wireless
- **Computer**
  - Hardware
- **Imaging**
  - Other

RELATED CASES

2015-920-0

▶ Aerospace and defense (i.e. satellite ground station, radar, military communication)

▶ Medical and industrial process (i.e. diagnosis system)

▶ Science (i.e. particle accelerator, X-ray-free electron laser systems, time resolved fluorescence microscopy)

ADVANTAGES

▶ This technology effectively boosts the performance of the analog-to-digital converter (ADC) and digital signal processing (DSP), and the time-stretch architecture scales with ADC and DSP technology, continually improving in resolution and speed as the electronic backend technology progresses.

▶ Table 1 lists several of the advantages of SiNA in comparison with a commercial vector network analyzer:

Specification	VNA	SiNA
Acquisition time	us to ms. Multiple sweeps required and is very slow for applications such as s-parameter measurements (can even take hours).	27 ns. Single-shot
Equivalent sampling rate	Signal is down-converted and digitized or a sampling oscilloscope is used.	750 GSps Burst sampling throughput using time-stretch.
Operational bandwidth	300 kHz to 110 GHz for Keysight N5251A	5 GHz to 40 GHz. Limited by modulator (can go up to 110 GHz) and dispersion (can be tuned)
Jitter in single-shot measurements	Not available	8 fs
Power	670 W for Keysight N5251A	80 W
Size	6-RU (Bench-top instruments are bulky.)	3-U Rackmount

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	10746630	08/18/2020	2015-920

USER DEFINED 2

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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Phase Transform For Object And Shape Detection In Digital Images
- Apparatus And Method For Multiple-Pulse Impulsive Stimulated Raman Spectroscopy
- Global Training Of Neural Networks For Phenomic Classification

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