#### SYCATUS Product Release at OVC2014



November 7th, 2014



# Profile of SYCATUS

- An innovative solution provider of measurement systems for optical devices and equipments.
- A spin-out company from R&D section of Agilent Technologies (former Keysight) owning accumulations of technologies, experiences and achievements.
  - Certified Solution Partner of Keysight Technologies



- A one-stop supplier of optimum combination of hardware, software and service with precise project managements.
- An evolving solution pioneer for world-wide business in Japan, China and USA.
  - Leading Collaborative Business with Denkei in China





# **SYCATUS History**

- 2004 Start of Agilent Technologies R&D Local Branch in Japan
- '2005 Release of N4373A Lightwave Component Analyzer
- '2006 Release of N4917A Optical Receiver Stressed Test Solution
- '2007 Release of N4371A RIN Measurement Solution



- 2009 Establishment of SYCATUS Corporation Agilent Technologies Authorized Service Provider certification
- 2011 Release of A0010A 40GHz RIN Measurement System Certification of Agilent Technologies Solutions Partner certification
- '2012 Start of Business in China, Exhibition at CIOE2012
- 2013 Release of A0040A Optical Noise Analyzer Start of Business in US



- '2014 Exhibition at OFC2014
  - Release of IEEE802.3ba100GbE Stressed Receiver Test Solution



SYCATUS

Ега

Agilent Era

#### SYCATUS Business in World Wide Customers

• Providing Only-One solutions developed in Japan to World Wide market



#### A0040A Optical Noise Analyzer Overview

- Industry first Optical Frequency Noise Spectrum measurement solution
- Powerful analysis tool of Narrow Linewidth Lasers like ITLA or μ-ITLA
- Essential for the development and manufacturing of lasers and transceivers for 100G/400G Digital Coherent Transmission Systems
- Developed cooperatively with National Institute of Advanced Industrial Science and Technology (AIST, Japan)







# A0040A Optical Noise Analyzer Diagram

Combination of SYCATUS and Keysight products



Keysight

#### A0040A Optical Noise Analyzer Configuration

Instruments	Optical Frequency Noise Measurement Bandwidth			
	12.5 MHz	20 MHz	80 MHz	
Keysight Technologies X-Series Signal Analyzer	N9010A, N9020A or N9030A #503/B25	N9010A, N9020A or N9030A #503/B40	N9020A or N9030A #503/B1X	
Keysight Technologies VXA Vector Signal Measurement Apprication		N9064A #1FP		
SYCATUS Optical Noise Analyzer Optical Testset, Software	A0040A #013	A0040A #020	A0040A #080	





#### A0040A Optical Noise Analyzer Features

- Measurement of Optical Frequency Noise as Power Spectrum Density
  - Complete, Accurate and Repeatable measurement of Optical Frequency Noise
- Analysis of White Noise, Lorentzian Linewidth and 1/f Noise
  - Easy extraction of White Noise portion
  - Supporting calculation of Lorentzian Linewidth
- Detection of Spurious Noise caused by Dither or EMI
- Simulation of Laser Linewidth of conventional interferometory
  - Calculation of linewidth from measured optical frequency noise spectrum
- Including Delayed Self-Heterodyne Interferometer
  - Supporting conventional linewidth measurement
- No reference laser source, No frequency tuning
  - Easy and Stable measurement



#### Analysis of Optical Frequency Noise Spectrum

- 1/f Noise + White Noise model
  - Separation of 1/f Noise portion and White Noise portion
- Detection of Spurious Noise





#### A0040A Optical Noise Analyzer Sensitivity



# Analysis of White Noise and Lorentzian Linewidth



• Lorentzian Linewidth is calculated by averaging the white noise in the frequency range specified by the start frequency and above

#### Measurement and Simulation of Conventional Linewidth

- A0040A Optical Noise Analyzer includes Delayed Self-Heterodyne
  Interferometer for conventional Linewidth Measurement
- A0040A Optical Noise Analyzer also Simulates Delayed Self-heterodyne
  Interferometory Linewidth from measured optical frequency noise spectrum



# A0040A New Feature : <1 s High-Speed Mode

- Rapid measurement of White Noise less than 1 Second
- Excellent Correlation with Normal Mode
- Significant Improvement of measurement efficiency
- Enabling white noise measurement in All Wavelength Channel in reasonable period
- Quick Analysis for tuning in development of Lasers



## A0040A Optical Noise Analyzer Applications

- Development, manufacturing and quality control of laser sources such as ITLA or Micro-ITLA for Digital Coherent Transmission
  - Measurement of Lorentzian Linewidth
  - Detection of the effects of Dither/EMI
- Development and quality control of Digital Coherent Transceivers
  - Evaluation and control of laser sources from point of view of correlation between Optical Frequency Noise and Transmission Performance
- Development, manufacturing and quality control of Sensing Laser Sources



#### A0010A RIN Measurement System Overview

- The Only One, World Standard RIN Measurement System
- Essential tool for intensity noise evaluation of 100G/400G PAM4 Lasers
- Developed by SYCATUS engineers in Agilent (former Keysight) R&D period
- Extended performances replacing Agilent 71400C Lightwave Signal Analyzer





# A0010A RIN Measurement System Diagram

Combination of SYCATUS and Keysight products



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#### A0010A RIN Measurement System Configuration

Instruments	RIN Measurement Bandwidth			
	100 kHz to 3 GHz	10 MHz to 20 GHz	500 MHz to 40 GHz	
Keysight Technologies X-Series Signal Analyzer	N9010A, N9020A or N9030A #503/PFR	N9010A, N9020A or N9030A #526/PFR	N9010A or N9030A #544/PFR	
Keysight Technologies Digital Multimeter	34410A			
SYCATUS RIN Measurement System Optical Receiver, Software	A0010A #003	A0010A #020	A0010A #040	





#### A0010A RIN Measurement System Features

- Broadband in both Wavelength and Electrical Frequency
  - O-Band to L-Band, up to 40 GHz
  - 850 nm MMF measurement available
- Accurate and High-Sensitivity measurements accepted by world-wide users
  - Decreasing measurement uncertainty by using SYCATUS original calibration method
  - High-power input improving signal to noise ratio of measurement
- Relaxation Oscillation Frequency measurements for laser
- Optical Modulation Index measurement available(option)
  - For Analog Optical Transmission equipments for Optical CATV or Radio over Fiber





#### Broadband, Various Wavelength RIN Measurement

- RIN measurement up to 40 GHz
  - O-band to L-Band
  - EML for PAM4
  - ITLA, µ-ITLA for Digital Coherent

- RIN measurement for 850 nm MMF lasers
  - Up to 20 GHz

#### - High-speed VCSEL



#### Accurate and High-Sensitive RIN Measurement

- · Less than -160 dB/Hz Sensitivity
- Stable and Repeatable Measurement in Various Optical Power





# Improved Measurement SNR by High Input Power

 Maximum optical input power up to +10 dBm (up to +7 dBm for 40 GHz and MMF model) significantly improves the measurement Signal-to-Noise (S/N) Ratio





#### **Relaxation Oscillation Frequency Measurement**

- Estimation of Modulation Bandwidth from Relaxation Oscillation Frequency
  - Correlation between  $f_{relax}$  and Modulation Bandwidth of DML
- Screening of lasers before module assemblies
  - Easy measurement without high-frequency assemblies
  - Defect of EML can be detected by  $f_{relax}$

Relaxation Oscillation Frequency is obtained by Marker Function of A0010A RIN Measurement Software



## **Optical Modulation Index Measurement Option**

- Multiple Carrier OMI Measurement at the same time
- Verified by standard OMI source developed by SYCATUS
- Standard OMI solutions for Optical CATV equipments in Japan
- Supporting Digital Modulation



#### A0010A New Lineup 26.5 GHz Bandwidth

- Fully utilizing Keysight signal analyzer bandwidth of option 526 : 26.5 GHz
- Proper analysis bandwidth for 100GbE lasers







# A0010A RIN Measurement System Applications

- Development, manufacturing and quality control of laser sources for Any Kinds of Optical Communications
  - Becoming Essential Measurement for 100G/400G PAM4
  - Analog Applications of Optical CATV or Radio over Fiber
- Relaxation Oscillation Frequency Measurement for Laser Screening
  - DML
  - EML



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