

AP2441B/AP2443B Optical Complex Spectrum Analyzer

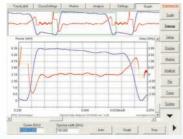
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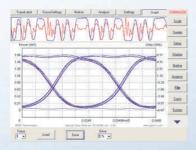
TIME DOMAIN MEASUREMENT Temporal resolution 75fs max., bandwidth >6THz max.

FREQUENCY DOMAIN MEASUREMENT Resolution 20MHz (0.16pm), C and L band

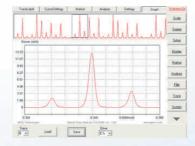
CHIRP & PULSE



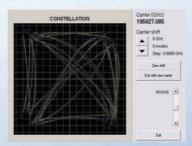
PHASE & INTENSITY EYE DIAGRAM



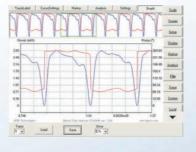
SHORT PULSES



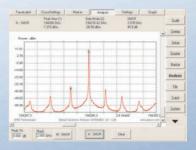
CONSTELLATION



PHASE MODULATION



ULTRA HIGH RESOLUTION OPTICAL SPECTRUM ANALYZER



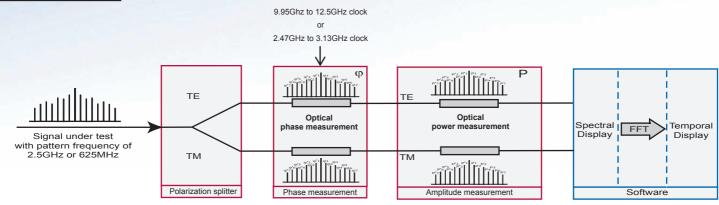
Measurement principle

While optical spectrum analyzer can only measure power of a modulated signals, Apex Technologies complex spectrum analyzer is able to measure also the optical phase.

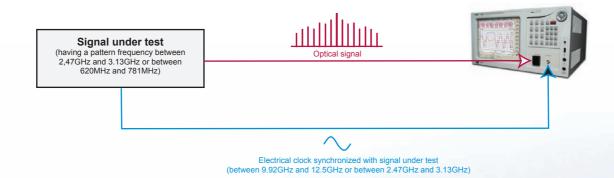
The patented method of the AP2441B/AP2443B is based upon a spectral analysis of the optical field, of which the amplitude and the phase of each frequency component are analyzed when all components are spaced by a fixed frequency (Fr1=2.5GHz or Fr2= 625MHz).

By knowing the amplitude and the phase of each spectral component, the temporal variations of the amplitude and the phase are calculated by the Fourier transform, providing the intensity and the chirp or phase as a function of time.

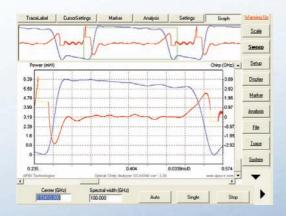
Block diagram :



Measurement configuration



Application examples



Time resolved chirp measurement :

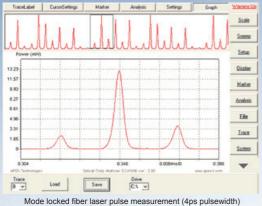
Time resolved chirp is an important parameter to predict transmitters performances in a transmission system.

AP2441B/AP2443B is the best solution in question of accuracy, repeatability and measurement time, for chirp measurement at high bit rates.

Moreover Apex Technologies complex spectrum analyzer can measure the optical pulse shape in the same measurement.

For mach-zhender modulator, it is also possible to display the Alfa parameter instead of the chirp.

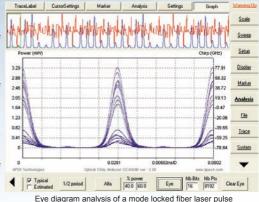
AP2441B/AP2443 Optical Complex Spectrum Analyzer

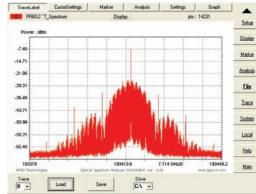


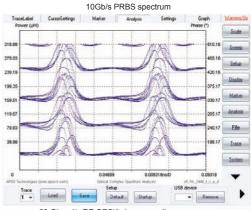
Short pulses measurement :

Thanks to the complex spectral analysis the bandwidth principle. of AP2441B/AP2443B is determined by the wavelength range of the instrument. So, the maximum temporal resolution of AP2441B/AP2443B is 75fs, giving the capability to measure ultra short pulses used in high bit rates systems.

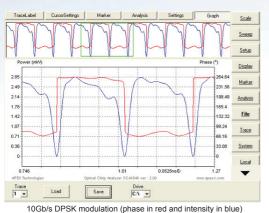
Compared to a standard oscilloscope having a maximum bandwidth of 80GHz, AP2441B/AP2443B have a ◀ Flysted 1/2 period maximum bandwidth >6THz!











Carrier (GHz) CONSTELLATION 192697.776 Carrier shift 0 GHz 0 modes v Step : 0.6694 GHz A. B. Salation

20 Gbaud/s RZ-QPSK constellation Γ

High resolution spectrum analyzer : AP2441B/AP2443B can be used as an ultra high resolution OSA to characterize spectral width of modulated signals.

Optical phase analyzer :

A lots of new modulation formats appeared using intensity but also phase modulation in long distance optical transmission.

Apex Technologies complex spectrum analyzer is the only instrument able to measure these phase modulations :

New modulation formats :

ROTATE

It is now possible to characterize directly a phase modulation, and display a phase eye diagram and a constellation for any bite rate in a DPSK. QPSK. Duo-binary... modulation.

Μ	ain frame and software specifications
	Auto measurement, zoom function, zoom to scale, auto calibration, peak
OSA software functionalities	search, line width, SMSR, markers, horizontal and vertical lines, peak
	centre,
Complex OSA software	Auto measurement, zoom, averaging, auto calibration, alfa parameter
functionalities	analysis, phase and intensity eye diagram, constellation, polarization split,
Tunctionanties	accuracy estimation, total power measurement
Trace	Up to 6traces
Screen	10.4inch, color TFT,
Front keyboard	Yes
USB connector	Yes
Internal memory	More than 1,000 traces
File format	Trace file (.dat, .txt), setup file, screen copy (.bmp), marker table
Mouse and keyboard	Yes (USB type in front panel)
GPIB	Yes
Ethernet	Yes (10/100 base T)
Operating temperature	$+10^{\circ}$ C to $+35^{\circ}$ C
Power requirement	AC 100 to 120V / 200 to 250V, 50/60Hz
Optical input	FC/PC SMF28
Clock input	SMA

Specifications are subject to change without notice.

September 2008

AP2441B/AP2443B Optical Complex Spectrum Analyzer

AP2441B AP2443B Optical spectrum analyzer specifications Wavelength measurement range 1525nm to 1607nm 1520nm to 1630nm Wavelength span range 80pm to 82nm 80pm to 110nm Wavelength resolution(@3dB) ^d 20MHz (0.16pm) and 100MHz (0.8pm)
Wavelength measurement range1525nm to 1607nm1520nm to 1630nmWavelength span range80pm to 82nm80pm to 110nmWavelength resolution@3dB)20MHz (0.16pm) and 100MHz (0.8pm)Measurement level range**Absolute accuracy****-70dBm (monochromatic) to +10dBmAbsolute level accuracy****-70dBm (monochromatic) to +10dBmAbsolute level accuracy****-70dBm (monochromatic) to +10dBmAbsolute level accuracy****-240 dB @ +/- 1pm**>60dB @ +/- 3pmSpurious free dynamic d55dB Typical (50dBmin)Sweep time d*5s for 55m**
Wavelength span range80pm to 82nm80pm to 110nmWavelength absolute accuracy $a^{b,c}$ +/-3pm+/-3pmWavelength resolution(@3dB)20MHz (0.16pm) and 100MHz (0.8pm)Measurement level range $a^{b,c}$ -70dBm (monochromatic) to +10dBmAbsolute level accuracy $a^{b,c}$ +/- 0.3dBLevel repeatability $a^{b,c}$ +/- 0.2dBClose-in dynamic range $a^{b,c}$ >40 dB @ +/- 1pmSpurious free dynamic $a^{b,c}$ 55dB Typical (50dBmin)Sweep time $a^{e,c}$ 5s for 55nmSpurious free dynamic $a^{b,c}$ Ss for 55nmOptical inputFC/PC for SM fiberTunable laser output>-7dBmInternal absolute WL calibratorYesDisplay capabilitiesScaleX scaleWavelength in nm or frequency in GHzY scaleOptical complex spectrum analyzer specificationsWavelength measurement range1525nm to 1607nmClock frequencyFclk1 = 9.92GHz to 12.5GHz or Fclk2 = 2.47 to 3.13GHzClock frequencyFclk1 = 9.92GHz to 3.12GHz and Fr2 = 620MHz to 781MHzClock frequencyFrl = 1.5GHz to 3.12GHz and Fr2 = 620MHz to 781MHz(option OCSA03)(see pattern table below)Measurement level range $b^{a,c}$ -55dBm to + 10dBmPattern frequencyFrl = 1.5GHz to 3.12GHz and Fr2 = 375MHz to 781MHz(option OCSA03)(see pattern table below)Measurement level range $b^{a,c}$ -55dBm to + 10dBmMaximum temporal resolution $b^{a,c}$ -55dBm to + 10dBmMaximum temporal resolution $b^{a,c}$ -55dBm to + 10dBm<
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Wavelength resolution (@3dB) ^d 20MHz (0.16pm) and 1000 MHz (0.8pm) Measurement level range ^{a be} -70dBm (monochromatic) to +10dBm Absolute level accuracy ^{a be} +/- 0.3dB Level repeatability ^{a bde} +/- 0.2dB Close-in dynamic range ^{a be} >40 dB (a) +/- 1pm Spurious free dynamic ^d 55dB Typical (50dBmin) Sweep time ^{de} 5s for 55nm Sweep time ^{de} 5s for 55nm Tunable laser output >-7dBm Internal absolute WL calibrator Yes Display capabilities Wavelength in nm or frequency in GHz X scale Wavelength in mor of frequency in GHz V scale Optical power in mW or dBm Optical complex spectrum analyzer specifications Wavelength measurement range 1525nm to 1607nm 1520nm to 1630nm Clock frequency Fclk1 = 9.92GHz to 12.5GHz or Fclk2 = 2.47 to 3.13GHz Clock frequency Clock frequency Frl1 = 2.48GHz to 3.12GHz and Fr2 = 37SMHz to 781MHz (see pattern frequency Frl = 1.5GHz to 3.12GHz and Fr2 = 37MHz to 781MHz (option OCSA03) (see pattern table below) Measurement tevel range ^h -55dB to + 10dBm Maximum temp
Measurement level range ** -70dBm (monochromatic) to +10dBm Absolute level accuracy *** +/- 0.3dB Level repeatability **** +/- 0.2dB Close-in dynamic range *** >40 dB @ +/- 1pm Spurious free dynamic *** 55dB Typical (50dBmin) Sweep time ** 55 for 55nm Optical input FC/PC for SM fiber Tunable laser output >-7dBm Internal absolute WL calibrator Yes Display capabilities X scale Wavelength in nm or frequency in GHz Y scale Optical power in mW or dBm Optical complex spectrum analyzer specifications Wavelength measurement range 1525mm to 1607mm Clock frequency Fclk1 = 9.92GHz to 12.5GHz or Fclk2 = 2.47 to 3.13GHz Clock frequency Fr1 = 2.48GHz to 3.12GHz and Fr2 = 620MHz to 781MHz Clock power 0 to +10dBm Pattern frequency Fr1 = 1.5GHz to 3.12GHz and Fr2 = 375MHz to 781MHz (option OCSA03) (see pattern table below) Measurement level range* 5s 7s Maximum temporal resolution * 95fs 7s Measurement level range * 5s 7s <t< td=""></t<>
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Y scale Optical power in mW or dBm Optical complex spectrum analyzer specifications Wavelength measurement range 1525nm to 1607nm 1520nm to 1630nm Clock frequency Fclk1 = 9.92GHz to 12.5GHz or Fclk2 = 2.47 to 3.13GHz Clock frequency (option OCSA03) Fclk1 = 6GHz to 12.5GHz or Fclk2 = 1.5GHz to 3.13GHz Clock power 0 to +10dBm Pattern frequency Fr1 = 2.48GHz to 3.12GHz and Fr2 = 620MHz to 781MHz (option OCSA03) (see pattern table bellow) Pattern frequency Fr1 = 1.5GHz to 3.12GHz and Fr2 = 375MHz to 781MHz (option OCSA03) (see pattern table below) Measurement level range h -55dBm to + 10dBm Maximum temporal resolution 1 95fs 75fs Chirp accuracy 8 75 75 Measurement time 8 5s 7s Display capabilities 7s 7s Display capabilities 7s 10dBm, chirp in GHz, phase in degree, alfa parameter Y scale Intensity in mW or dBm, chirp in GHz, phase in degree, alfa parameter 116 parameter OSA01 Continuous and step by step Optical Tunable laser source 0SA02 Optical tracking generator for transmission measurements OCSA03
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Clock frequency (option OCSA03)Fclk1 = 6GHz to 12.5GHz or Fclk2 = 1.5GHz to 3.13GHzClock power0 to +10dBmPattern frequencyFr1 = 2.48GHz to 3.12GHz and Fr2 = 620MHz to 781MHz(option OCSA03)(see pattern table bellow)Measurement level range h-55dBm to + 10dBmMaximum temporal resolution t95fs75fs75fsChirp accuracy g+/- 60MHzMeasurement time g5s7sDisplay capabilitiesX scaleTime in ps or Wavelength in nm or Frequency in GHzY scaleIntensity in mW or dBm, chirp in GHz, phase in degree, alfa parameterOSA01Continuous and step by step Optical Tunable laser sourceOSA02Optical tracking generator for transmission measurementsOCSA03No bit rate limitation option (see pattern table below)
Clock power0 to +10dBmPattern frequencyFr1 = 2.48GHz to 3.12GHz and Fr2 = 620MHz to 781MHz (see pattern table bellow)Pattern frequency (option OCSA03)Fr1 = 1.5GHz to 3.12GHz and Fr2 = 375MHz to 781MHz (see pattern table below)Measurement level range h-55dBm to + 10dBmMaximum temporal resolution t95fs75fsChirp accuracy g+/- 60MHzMeasurement time g5s7sDisplay capabilities7sV scaleTime in ps or Wavelength in nm or Frequency in GHz alfa parameterY scaleIntensity in mW or dBm, chirp in GHz, phase in degree, alfa parameterOSA01Continuous and step by step Optical Tunable laser source Optical tracking generator for transmission measurements No bit rate limitation option (see pattern table below)
Pattern frequency $Fr1 = 2.48$ GHz to 3.12 GHz and $Fr2 = 620$ MHz to 781 MHz (see pattern table bellow)Pattern frequency (option OCSA03) $Fr1 = 1.5$ GHz to 3.12 GHz and $Fr2 = 375$ MHz to 781 MHz (see pattern table below)Measurement level range h-55dBm to + 10dBmMaximum temporal resolution T95fs75fs75fsChirp accuracy g+/- 60MHzMeasurement time g5s7sDisplay capabilitiesX scaleTime in ps or Wavelength in nm or Frequency in GHzY scaleIntensity in mW or dBm, chirp in GHz, phase in degree, alfa parameterOptionsOptionsOSA01Continuous and step by step Optical Tunable laser source Optical tracking generator for transmission measurements No bit rate limitation option (see pattern table below)
Pattern frequency (see pattern table bellow) Pattern frequency Fr1 = 1.5GHz to 3.12GHz and Fr2 = 375MHz to 781MHz (option OCSA03) (see pattern table below) Measurement level range h -55dBm to + 10dBm Maximum temporal resolution T 95fs 75fs Chirp accuracy g +/- 60MHz Measurement time g 5s 7s Display capabilities 7s Display capabilities 7s V scale Time in ps or Wavelength in nm or Frequency in GHz Y scale Intensity in mW or dBm, chirp in GHz, phase in degree, alfa parameter Options Optical Tunable laser source OSA01 Continuous and step by step Optical Tunable laser source OSA02 Optical tracking generator for transmission measurements OCSA03 No bit rate limitation option (see pattern table below)
Pattern frequency (option OCSA03) Fr1 = 1.5GHz to 3.12GHz and Fr2 = 375MHz to 781MHz (see pattern table below) Measurement level range ^h -55dBm to + 10dBm Maximum temporal resolution ^T 95fs Chirp accuracy ^g +/- 60MHz Measurement time ^g 5s Display capabilities X scale Time in ps or Wavelength in nm or Frequency in GHz Y scale Intensity in mW or dBm, chirp in GHz, phase in degree, alfa parameter Options Options OSA01 Continuous and step by step Optical Tunable laser source OSA02 Optical tracking generator for transmission measurements OCSA03 No bit rate limitation option (see pattern table below)
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OSA02Optical tracking generator for transmission measurementsOCSA03No bit rate limitation option (see pattern table below)
OCSA03 No bit rate limitation option (see pattern table below)
OCSA04 Group delay and chromatic dispersion analysis
Optical complex spectrum analyzer pattern length
The bit rate of the signal under test divided by the pattern length must be included in the pattern frequency ran
2.48Gb/s 4.96Gb/s 9.92Gb/s 19.84Gb/s 39.68Gb/s 79.36Gb/s 158.72Gb/s 317,44Gb/s 634,88C
Bit rate to to to to to $\frac{1}{2}$ bit rate to to to to to to to to to
<u>3.12Gb/s</u> 6.24Gb/s 12.5Gb/s 25Gb/s 50Gb/s 200Gb/s 400Gb/s 800Gt
Bit rate to
(OCSA03) 3.12Gb/s 6.24Gb/s 12.5Gb/s 25Gb/s 50Gb/s to 100Gb/s 200Gb/s 400Gb/s 800Gb/s
<u>5.1200/5</u> 0.2400/5 12.500/5 2500/5 5000/5 2000/5 40000/S 80000

a) At 1550nm

length for

Fr1 Pattern length for

Fr2

b) At 0dBm

c) After wavelength calibration

1bit

4 bits

2 bits

8 bits

4 bits

16 bits

d) Typical

f) If modulated signal covers the complete wavelength range g) Maximum chirp deviation measured on a 2.5GHz sinusoidal signal with 30% modulation ratio

8 bits

32 bits

h) Power range of complex spectrum components for an accurate analysis

16 bits

64 bits

e) Resolution 100MHz

i) The pattern repetition frequency must be included in the pattern frequency range, the clock and the pattern must be synchronised

32 bits

128 bits

64 bits

256 bits

128 bits

512 bits

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256 bits

1024 bits

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