DMOptics

TEST EQUIPMENT SPECIALISTS

APPLICATION NOTE

High bit rate modulated signal OSNR measurement

Introducing the Yokogawa AQ6370 and AQ6319 unique DUAL TRACE function

During, the research, development and system integration of high speed transmission systems, the correct OSNR (optical signal to noise ratio) must be verified.

Previously, when transfer rates did not exceed 2,5GBit/s, almost all optical spectrum analysers were capable of measuring the OSNR correctly and accurately.

Together with higher bit rates of 10GBit/s and 40/43,5GBit/s, suppliers are developing different modulation systems.

Nowadays not only NRZ (non return to zero) but also RZ (return to zero) coding and different phase modulations are becoming popular due to their superior efficiencies.

Since high bit rate modulation broadens the signal, it's important to use a special technique to measure OSNR values correctly.

Various OSA suppliers offer different solutions that more or less solve the problem. This application note introduces the true solution for this kind of measurement.

YOKOGAWA

THE ADVANTAGES OF OUR SOLUTION

Due to the unique flexibility in resolution setting in combination with the DUAL TRACE evaluation function, our solution is perfect for measuring modulated signal OSNR.

- High resolution accuracy.
- Resolution setting from 0.02 to 2nm, suitable for both Signal and Noise measurements.
- Free space input prevents any additional offset to be introduced from connecting damaged fibre surfaces to the analyser.
- Perfect stray light suppression using chopper or switch mode which achieves more than 62dB dynamic 50GHz away from peak.
- High resolution in combination with steep filters using multi-pass filter technology.
- An extremely robust system that is able to withstand vibrations and shocks which may occur in production facilities.

THE MEASUREMENT TASK

Figure a.) shows a 10GBit/s NRZ coded signal measured with different resolution settings. At the highest resolution setting we see the "side lines" caused by the signal modulation. Even with NRZ, the coding leads to a broadened signal with side lines at 10GBit/s lower and higher than the carrier wavelength. At an absolute wavelength of 1550nm, this means that we can observe peaks at +/-80pm either side of the carrier. Since these peaks carry a part of the signal energy as shown in Figure a.), we need to integrate the total energy to get the correct signal level. Since the highest part of the signal energy at 10GBit/s NRZ is distributed through a bandwidth of 160pm, we need at least a filter bandwidth of 200pm to catch the correct peak level.

This effect is more pronounced with RZ coding as it moves even more energy into the "side lines".
For 40GBit/s RZ coding this means that the main part of the signal energy is distributed through a bandwidth of 640pm when the center wavelength is 1550nm. We therefore need a resolution bandwidth of 1nm to get the correct noise level.

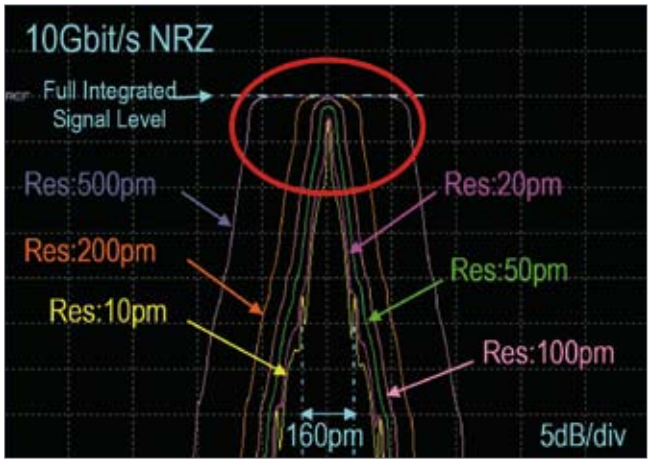

Figure a.) 10GBit/s NRZ signal measurement using 10pm to 500pm resolution settings; e.g. 50pm resolution measurement shows 1 dB less power than the real total signal power. More than 200pm resolution is required to measure the signal level to get the correct OSNR.

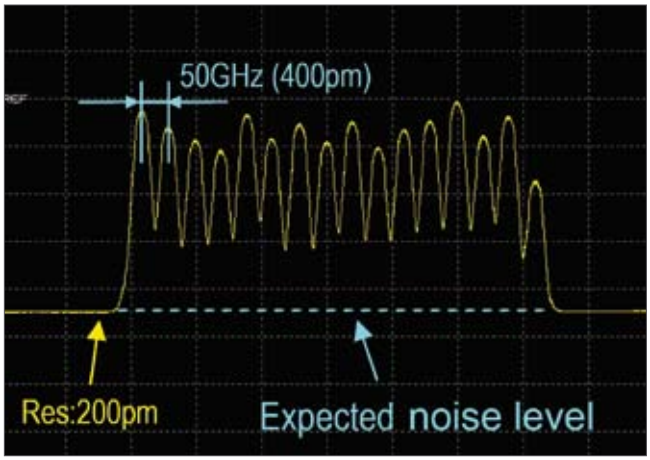

Figure. b.) 50GHz spacing DWDM signal measurement using a resolution of 200pm .This resolution can't measure the correct noise level.

Figure b.) shows a 10GBit/s modulated DWDM signal measured with an OSA using a resolution setting of 200pm, the resolution width which we discovered earlier to be required to measure the peak signal level. The graphs show that this resolution setting is unsuitable to measure the correct noise level indicated through the line "expected noise level". To get the correct noise level of a 50GHz spacing DWDM signal, we need to measure using a resolution of 20pm.

From these results we discover, that to measure the correct ratio between signal and noise (OSNR), a special measurement technique is required. Hence, this is why Yokogawa has introduced the key feature of DUAL TRACE function.

THE MEASUREMENT PROCESS

Measuring modulated Optical Signal to Noise Ratios with the Yokogawa AQ6319 and AQ6370 OSAs.

The basic setup of a DWDM system is shown in figure c. The full measurement is done in three steps. After connecting the multiplexed system output or the monitor output to the OSA input, proceed as follows.

- Beside the wavelength- and sensitivity setting, set a resolution of 0.2nm for 10GBit/s signal measurement and at least 1.0nm for 40GBit/s signal measurement to perform a single measurement on trace A.
- Fix trace A and perform a single measurement at high resolution of 20pm to obtain the correct noise level on trace B.
- Activate "Analysis" and choose WDM-Analysis. To perform the DUAL TRACE evaluations, activate the DUAL TRACE function by selecting the check box as shown. The target for the analysis of each trace will be:
  - TRACE A: trace subject to channel detection; calculates wavelengths and levels.
  - TRACE B: detects the noise level.

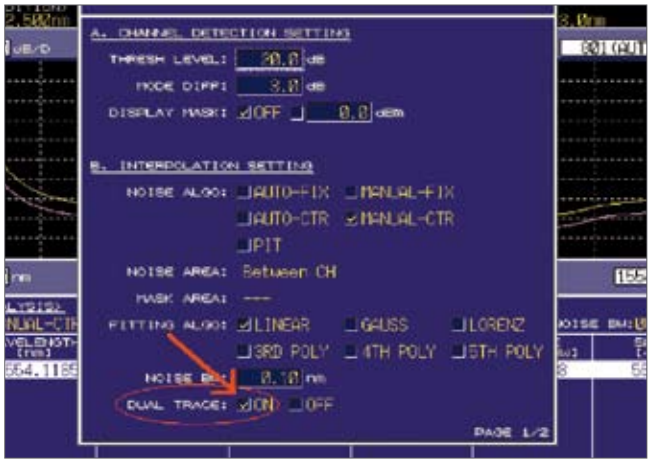

Figure. d.) Parameter setting options of AQ6370

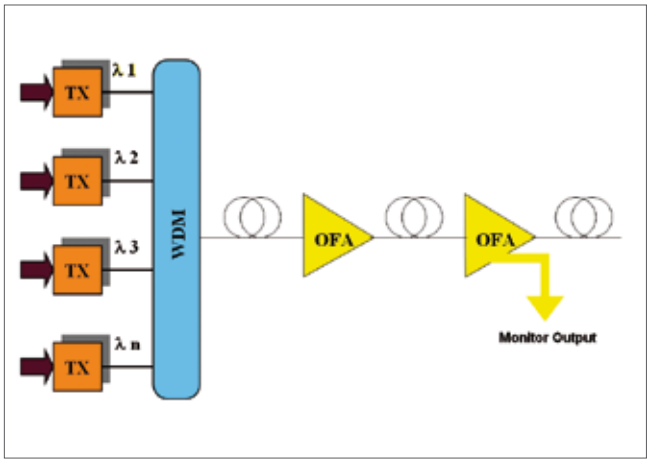

Figure. c.) Basic WDM setup.

WHAT ARE THE ALTERNATIVE SOLUTIONS?

- **Single high resolution measurement**
  Provides a correct noise evaluation for both narrow and wide spacing signals. The signal level cannot be obtained for both, 10GBit/s and 40GBit/s signals

- **Single wide resolution measurement**
  Provides a correct signal measurement depending on the real resolution for 10GBit/s and 40GBit/s signals. The noise level can not be detected correctly at a wide resolution setting.

- **Mathematical integration calculation**
  Since the signal is broadened depending on the format, ratio and rate of the modulation, an integration of the measured signal may also lead to a correct signal measurement result. The critical point will always be the need to detect all modulation lines. This point may lead to an error at high resolution measurement using an OSA with a low number of sampling points.

- **Error assumption and manual offset calculation**
  Depending on the experience of the engineer, an assumption of the measurement error can be done. This assumption may lead to a more correct result than a single high resolution measurement. The error size depends on the modulation format and rate.

- **DUAL TRACE Measurement**
  As the name suggests, it performs real measurements. Independently. Both the noise and the signal will be measured using two different resolution settings. Errors such as under sampling of the signal and resulting integration errors cannot occur. It is the best solution for OSNR measurement.

THE TOP TEAM TO MEET YOUR NEEDS

The AQ6319 and AQ6370 are perfectly suitable for OSNR measurement for all kinds of 10GBit/s and 40GBit/s phase and amplitude modulation. In the case of amplitude modulations, RZ and NRZ codings for example, are covered due to the very flexible resolution setting of both Yokogawa OSAs.

AQ6370 Resolution from 0.02nm to 2.0nm.

AQ6319 Resolution from 0.01 to 1.0nm.

Both instruments can be used for 10GBit/s modulation, signal and noise measurements. The AQ6370 is optimal for 40GBit/s OSNR measurements.