Time Domain Phase Derivative and Time Domain Wavelength Calculations

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Introduction

In the OBR, the time domain phase derivative is a temporal domain derivative calculated from the polarization weighted average of the measurement of the S and P complex responses of the device under test (DUT). The temporal domain derivative of phase is the definition of optical frequency; hence the time domain phase derivative can be scaled to wavelength. Intuitively, this data set represents the locally reflected wavelength. In the following note, the time domain phase derivative, and time domain wavelength calculations are detailed.

OBR Calculations of Time Domain Phase Derivative

The time domain phase derivative is calculated in the OBR as follows

$$d\phi[i] = \boldsymbol{arg}\{S[i] \cdot S^*[i+1] + P[i] \cdot P^*[i+1]\}$$

where S and P are the temporal domain complex responses measured on the s-polarization and p-polarization detectors respectively, and i is an array index over delay space. The ***arg*** function returns the four quadrant arctangent of the real and imaginary parts of its argument (commonly atan2(Im, Re)).

The OBR then scales this temporal domain phase derivative to temporal domain wavelength as follows:

$$TDW[i] = \frac{c}{\frac{d\phi[i]}{2\pi} \cdot \Delta\nu + \nu_{start}}$$

where c is the speed of light, $\Delta\nu$ is the frequency range, and ν_{start} is the start frequency of the laser sweep.

Distribution in the UK & Ireland

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Polarization Dependent Time Domain Phase Derivative

Polarization dependent time domain phase derivative curves do not exist in the commercial OBR software as of version 3.10.1; however they are readily calculable from the S and P vectors saved to a binary file. For more information regarding working with binary files, contact Luna customer support at support@lunainc.com.

The following algorithm is outlined for a single polarization state, s-polarization. The calculations for p-polarization follow by direct substitution of P for S.

1. Open the binary file that contains the complex S and P measurement data.

2. Calculate the polarization dependent phase derivative for a single polarization as follows

$$d\phi_S[i] = \boldsymbol{arg}\{S[i] \cdot S^*[i+1]\}$$

   where S is the temporal domain complex response measured on the s-polarization detector, and i is an array index over delay space. The ***arg*** function returns the four quadrant arctangent of the real and imaginary parts of its argument (commonly atan2(Im, Re)).

3. Calculate the polarization dependent time domain wavelength by scaling the phase derivative as follows

$$TDW_S[i] = \frac{c}{\frac{d\phi_S[i]}{2\pi} \cdot \Delta\nu + \nu_{start}}$$

   where c is the speed of light, $\Delta\nu$ is the frequency range, and ν_{start} is the start frequency of the laser sweep.

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