



**PDL – Matrix Method Measurement
with the OMU-953 Option**

PRELIMINARY

Overview

This application note provides background on how to do PDL and Insertion Loss measurements utilizing the Matrix Method using the OMU-953 option with Polarization State Controller.

Summary

The Model 2004 Optical CSA includes the capability to do PDL and insertion loss measurements on one channel at a time. Sweep, step and time mode measurements can be made. The measurement is done in conjunction with an HP/Agilent 8169A Polarization Controller (PSC), which can be automatically controlled directly from the CSA.

Performance Specifications	
Wavelength operating range	1520-1630 nominal
Insertion Loss uncertainty	
With Power Reference option	CSA specification with Power Reference
Without Power Reference option	CSA specification +0.1 dB over any 100 nm range without Power Reference
Dynamic Range	+10 to -95 dBm with -202 measurement option, +10 to -73 dBm with -201 measurement option
Polarization Extinction Ratio	>40 dB
Measurement Speed ² - 1 measurement	PDL measurement in 10 usec. Higher resolution & accuracy at higher measurement times.
Measurement Speed ² - PDL vs Wavelength	
For broadband devices- swept	
For broadband devices- stepped	
For narrow band devices- swept	
For narrow band devices- stepped	
PDL Measurement Range	0.005 to 40 dB
PDL Measurement Accuracy ¹	
Absolute power from device >-30 dBm	((+0.015 dB/-0.005 dB) ± .03% of PDL)
Absolute power from device <-30 dBm	((+0.010 dB/-0.005 dB) ± .03% of PDL) typical
PDSR Polarization Dependent Split Ratio Accuracy	((+0.020 dB/-0.010 dB) ± .15% of PDL)
Option contents	±(0.005 dB + .03% of PDSR) typical SCPI and front panel PDL (max-min) capability and PDL offset value, FC/PC-FC/APC patch cord (CSA to polarization controller), and Model A11896A polarization controller.

PDL Application Panel

The PDL application is found by pressing **APPS** then the **PDL Measurement Application** softkey.

Maximize Pol

The polarization controller Polarization setting is adjusted to maximize the absolute signal level on the power reference channel (5). This adjustment is done to the nearest 1.0° setting.

Measure PDL and IL on Channel 1

Using the current sweep settings, four sweeps are taken on channel 1 in each of the four Mueller Matrix states. Power reference is required in ALL sweep modes. Wavelength reference is recommended in swept mode operation. After the four sweeps are completed the data is post processed to compute PDL and IL. If the Wavelength reference was enabled, then the data is adjusted so that each data point lines up on the same wavelength value, otherwise sweep-to-sweep variation of wavelength in a TLS can cause significant errors in the resulting measurement. Both PDL and IL are computed in dB units.

IL Display Units

- Insertion Loss
- Transmission

The user may choose to have the insertion loss graph inverted or not. When Insertion Loss is chosen the resulting data is positive. When Transmission is chosen the resulting data is negative.

Return to Apps

Return to the main applications menu panel.

System Connections

Optical Connections

TLS -> Pol Controller -> CSA "TLS IN"
CSA "Pref" -> Channel 5 (Pref)
CSA "Wref" -> Channel 6 (Wref) [optional]
CSA "To DUT" -> DUT -> Channel 1
Channel 2 installed (connection does not matter)

Electrical Connections

TLS Trigger Output -> CSA { "Meas Start" | "IN 1" | "IN 2" } (BNC)
CSA "EXT. DEVICE CONTROLLER" -> PSC (GPIB)

Accuracy

Polarization Controller Operation

The polarization state controller may be automatically or manually operated. When **Measure PDL and IL on Channel 1** is pressed, the CSA will attempt to take four sweeps at the following polarization settings.

	Pol.	$\lambda/4$	$\lambda/2$
Sweep 1	X	X	X
Sweep 2	X	X	X + 45.0°
Sweep 3	X	X	X + 22.5°
Sweep 4	X	X + 45.0°	X

When measuring PDL in manual operation, it is necessary to choose a sweep setup in which a trigger signal is presented from the TLS to the CSA. When the CSA message "Waiting For Trigger" is seen, then the user may set the polarization controller and manually start a TLS sweep. Do this once for each of the four sweeps above and the CSA will compute PDL and IL.

Future versions of firmware will control the PSC automatically.

How PDL and IL are Computed

PDL and IL are computed using the Mueller Matrix formulas. The computation starts by taking four measurements at each of the sweep states listed above. The measurements are m1-m4.

m1	data from sweep 1	(dB)
m2	data from sweep 2	(dB)
m3	data from sweep 3	(dB)
m4	data from sweep 4	(dB)

Convert from dB to linear DUT Pout / Pin

$$m1 = 10^{(m1 / 10)}$$

$$m2 = 10^{(m2 / 10)}$$

$$m3 = 10^{(m3 / 10)}$$

$$m4 = 10^{(m4 / 10)}$$

$$m11 = (m1 + m2) / 2$$

$$m12 = (m1 - m2) / 2$$

$$m13 = m3 - m11$$

$$m14 = m4 - m11$$

$$T_{MAX} = m11 + [m12^2 + m13^2 + m14^2]^{1/2}$$

$$T_{MIN} = m11 - [m12^2 + m13^2 + m14^2]^{1/2}$$

$$IL = 10 * \log_{10}[(T_{MAX} + T_{MIN}) / 2] = 10 * \log_{10}[m11] \quad (\text{dB})$$

$$PDL = 10 * \log_{10}[T_{MAX} / T_{MIN}] \quad (\text{dB})$$

$$\text{Transmission} = -IL \quad (\text{dB})$$

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