



## Measuring Deep-Well Optical Devices with the CSA

### Overview

This application note describes how to measure devices with high dynamic range using the CSA. The setup of the optical system, tunable laser selection, and the CSA settings will all have an impact on the depth of the measurement. The CSA is capable of measuring very deep devices.

The key to measuring deep devices is to optimize the effective dynamic range (EDR). The following factors influence EDR: 1) power level to the meters; 2) TLS spontaneous emission level; 3) TLS speed; 4) level of filtering and averaging; and 5) measurement level selection.

### Optical System Setup: TLS Power Output Setting

There are two considerations here. First, in general, the more optical power from the TLS, the higher the EDR possible. Many TLS's have output power settings which either set an internal attenuator or set the current to the laser diode.

If a single range is being used (such as the AUTO ranges on the CSA), then the optical power should be set so that the maximum power through the device to the CSA is at or just below the top of one of these ranges. This will allow full utilization of the dynamic range for that CSA range.

If automatic stitching ranges are being used (see box below), then set the TLS to its maximum power. Stitching uses multiple ranges with multiple sweeps interlaced to gain additional EDR.

#### Accessing Automatic Stitching Ranges

Press the CHANNELS button; press the **Edit Channels...** softkey; press the **Manual-Set Selected Channels Measurement Range...** softkey; press the **Medium and Slow Ranges...** softkey; press the **Fixed Ranges A to E...** softkey; press the **Fixed Ranges C to E...** softkey; press the **Fixed Range E...** softkey; press the **Stitching...** softkey to bring up the Stitching Softkey Panel. Use the softkeys to select desired settings.

### Optical System Setup: TLS Output Port - High Power or Low Noise

Note that some TLS's have two outputs; one for high power and one for low noise. If a filter or any wavelength selective device is being tested, the optimum output will most likely be the low noise output. (This is because the spontaneous emission of the high power range may limit the optical dynamic range of the measurement.) If a switch or other non-wavelength selective device is being tested, the optimum output will most likely be the high power output.

## Optical System Setup: TLS Speed

The slower the TLS sweep speed, the more filtering the CSA can accomplish on the optical signal. Because many optical signals have significant sources of noise (in addition to the internal noise of the CSA measurement) slower sweeps will almost always result in higher EDR.

## Optical System Setup: Intervening Optics

Any optical loss in the optical connection between the TLS and the CSA can limit power and reduce EDR. Ensure the patch cords have nominal losses and that there are no other unnecessary optics in the path.

## Optical System Setup: Polarization Controller Loss

Any optical loss in the polarization controller (if one is being used) can limit power and reduce EDR. An 8169 polarization state controller typically has 2.5-3dB of loss when the polarizer is optimized. If it is higher than this, consider having the 8169 refurbished. Power loss is not uncommon on these controllers.

Regularly realigning the polarizer also maximizes power. This is accomplished in the CSA in APPS-PDL SETUP. The CSA performs this function automatically (see box below).

### Realigning the Polarizer Automatically Through the CSA

Press the **APPS** button; press the **PDL Measurement Setup...** softkey; press the **Maximize Power Through Polarizer** softkey.

## Optical System Setup: CSA Loss

The CSA's typical internal loss, when configured with an internal shutter, is 8 dB. When a sweep is run, the power at the reference channel should be roughly 8 dB below the TLS power. If there is a polarization controller, it should be approximately 12 dB below the TLS power.

## CSA Setup: Reference Channel Range

The CSA reference channel should be set to the first range above the maximum power measured during a measurement.

The easiest way to do this is to run an "Auto-Set Measurement Range" (see box below). The CSA will run a measurement, look at the maximum power, and set the ranges for the selected channels to the optimum range.

### Auto-Set Measurement Range

Press the **CHANNELS** button; press the **Edit Channels...** softkey; use the **Select/Deselect ALL Channels** softkey or the **Select Next Trace** softkey to select (highlight) the desired channels; press the **Auto-Set Selected Channels Measurement Range** softkey.

A second way of accomplishing this (see box below) is to set the power units to dBm, run a sweep noting the maximum power level on the reference channel. Set the range for that channel to the range that is just higher than the measurement channel.

#### **Manual-Set Measurement Range**

Press the **CHANNELS** button; toggle the **Power Mode** softkey until dBm is selected. Press the **START/STOP** button to run the sweep. To set the range, press the channels button; press the **Edit Channels...** softkey; use the **Select/Deselect ALL Channels** softkey or the **Select Next Trace** softkey to select (highlight) the desired channels; press the **Manual-Set Selected Channels Measurement Range...**; press the softkey corresponding to the appropriate wavelength range.

### **CSA Setup: Measurement Channel Range(s)**

The CSA measurement channel, which is connected to the DUT output, should be set to the first range above the maximum power level measured.

The easiest way to do this is to run an “Auto-Set Measurement Range” (see box on the bottom of page 2). The CSA will run a measurement, look at the maximum power, and set the ranges for the selected channels to the optimum range.

If additional EDR is desired, the measurement channel can be set to “stitching.” (See application note **031 Stitching** for more detailed information. See box on page 1 of this application note for instructions on accessing the Stitching Softkey Panel.) Note that stitching requires one sweep for each range specified. If the CSA is set to control the TLS automatically, it will handle all of the TLS settings to make this work properly.

### **CSA Setup: Reading Spacing**

At any specific TLS sweep speed, the wider the reading spacing, the more filtering that can be performed. This results in less noise and higher EDR.

### **CSA Setup: Samples to Average**

The optimum readings to average is maintained automatically by the CSA if this setting is set to auto.

## CSA Setup: Digital Filtering

The CSA can be set to filter out optical noise present in the system. This digital filtering is called smoothing. The smoothing choices available are varied and optimized for typical optical systems, without undue loss of information (see box below).

### To Enable Smoothing

Press the **CHANNELS** button; press the **Edit Channels...** softkey; select (highlight) the desired channel(s); press the **More...** softkey; press the **Filtering...** softkey; press the **Data Smoothing (0.000 ms)** softkey; enter the desired value using the keypad then press the **ENTER** button; toggle the **Data Smoothing Filter Type** softkey for the desired type.

## CSA Setup: Dark Calibration

Measuring the lowest optical power levels requires the use of dark calibration. Dark calibration corrects for the drift in the dark current of the photo diode in the measurement channels. To access dark calibration, press the **CHANNELS** button; press the **Do Dark Current Zero** softkey; and press the **Dark Current Calibration? Yes, Continue** softkey. The CSA will automatically close the shutter (if the shutter option is installed), stopping all light from the system, then perform the zero measurement on every channel, every range.

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