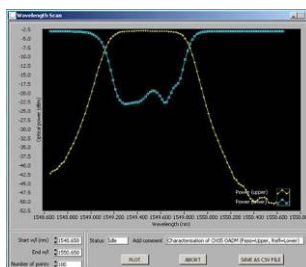


## Educator Kit

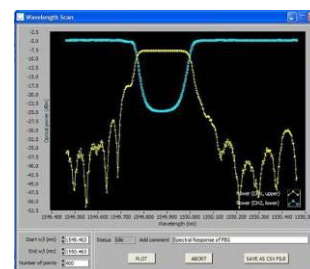
## ED-WDM Series

### COMPREHENSIVE LABORATORY BASED EDUCATIONAL PACKAGE IN WDM & DWDM COMPONENTS, SYSTEMS & BRAGG GRATINGS



Wavelength Scan of OADM

Wavelength Scan of Bragg Grating



#### MAIN FEATURES AND BENEFITS:

- Modular series of kits investigating WDM Components, DWDM, 1310/1550nm WDM & Bragg Gratings.
- Includes all fibre optic and optoelectronic hardware required to perform the experimental investigation.
- Extensive literature support including: student manual with relevant theory and experimental procedure and instructor's manual with full sample results.
- Background notes on fibre optic components and WDM systems.
- Saves significant course, literature and hardware development effort.
- Driver & display software for optional PC control & monitoring of instrument via USB interface.
- 3U 19" rack style modules allow flexible unit combination, future upgrade and expansion of kit when appropriate.

#### THE FULL ED-WDM SERIES EXPERIMENTAL INVESTIGATION ADDRESSES\*:

- Measurement of insertion, backreflection /return losses and determination of isolation/extinction ratios of a series of optical components at 1550nm & 1310nm
- Characterisation & examination of the narrowband wavelength response of Bragg grating and DWDM modules
- Investigation of temperature tuning of a Bragg grating and its role as a temperature sensor
- Measurement and plotting of light, voltage, current (LVI) characteristics of lasers with operating temperature
- Characterisation of a two channel DWDM system, examination of channel add/ drop, and measurement of system crosstalk / channel isolation (*a 4-Channel DWDM Ext. is also available*)
- Effect of wavelength drift on DWDM system crosstalk / channel isolation
- Investigation of crosstalk effects on the eye diagram / BER in DWDM systems (*requires BER(WDM) kit*)
- Assembly and characterisation of a two channel 1310nm/1550nm WDM system
- Fibre attenuation, length & chromatic dispersion measurements with 1310nm & 1550nm sources (*needs BER(WDM) kit*)

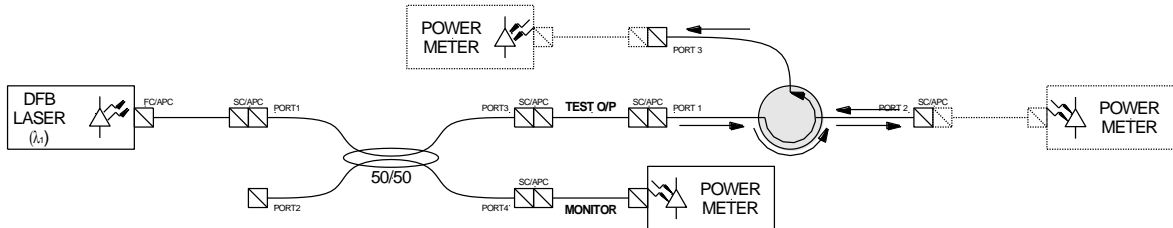
\*The full ED-WDM Series consists of a base kit, WDM COMPONENTS, and three extension modules: 1310/1550 WDM Ext, DWDM Ext and BRAGG Ext. Full details of the experiments and equipment specifications in each unit are provided overleaf.

## Laboratory Exercises

The full ED-WDM Series consists of a base kit, WDM COMPONENTS, and three extension modules, 1310/1550 WDM Ext, DWDM Ext and BRAGG Ext., which allow immediate or future expansion of the kit as desired. The full series of kits enable students to consolidate their knowledge and understanding and to acquire practical experience in the investigation, analysis and characteristics of optical fibre components, laser diodes, various Wavelength Division Multiplexed (WDM) systems, and Bragg Gratings. A full list of the available laboratory exercises in each unit is as follows: -

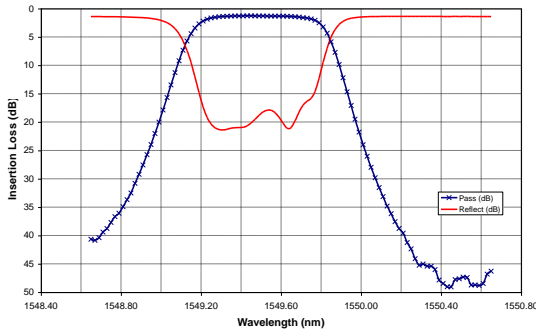
### WDM COMPONENTS:

- Measurement of insertion losses and backreflection / return loss for appropriate output ports of: a fused biconical taper (FBT) coupler, a FBT WDM, an isolator, a circulator, an Optical Add/Drop Multiplexer (OADM), and backreflection from PC and APC connectors

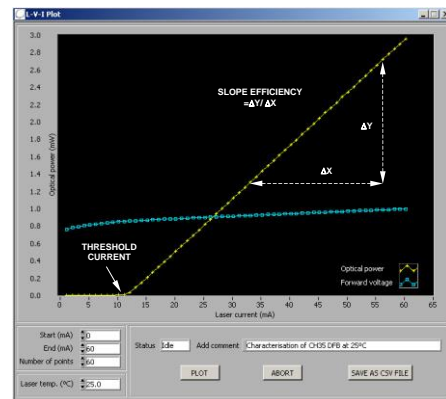


### Circulator Characterisation

- Determination of isolation/extinction ratios for appropriate output ports of an isolator, circulator and OADM
- Characterisation and examination of the narrowband (~1.5nm) wavelength response of a Bragg grating and OADM



Measured wavelength response of OADM

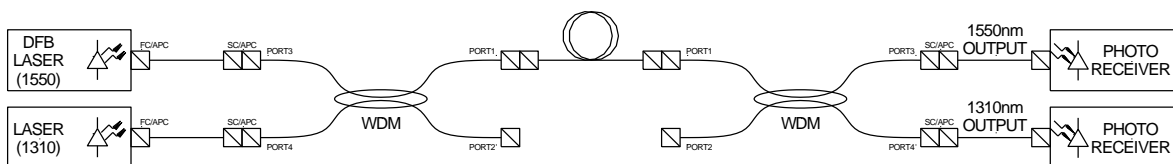


Laser LVI Plotting Software

- Measurement and plotting of the variations in LVI characteristics of an ITU Grid DFB laser ( $\lambda \sim 1550\text{nm}$ ) with operating temperature (*requires a PC to run driver software supplied*)

### 1310/1550 WDM Ext:

- Measurement of insertion losses and backreflection / return losses for various components supplied with WDM COMPONENTS at 1310nm and comparison with 1550nm measurements.
- Fibre length and attenuation measurement at 1310nm and 1550nm
- Estimation of fibre chromatic dispersion using pulsed 1310nm & 1550nm lasers and fibre ring resonator (*requires BER(WDM)*).

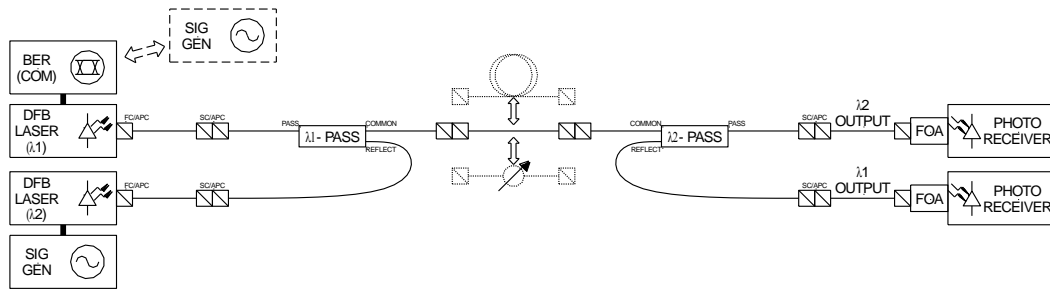


Basic 1310nm / 1550nm WDM Transmission System

- Assembly and characterisation of a two channel 1310nm & 1550nm WDM system

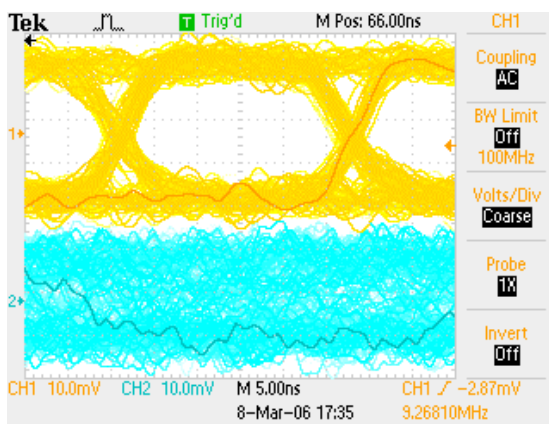
## DWDM Ext:

- Assembly, investigation and characterisation of a two channel DWDM system

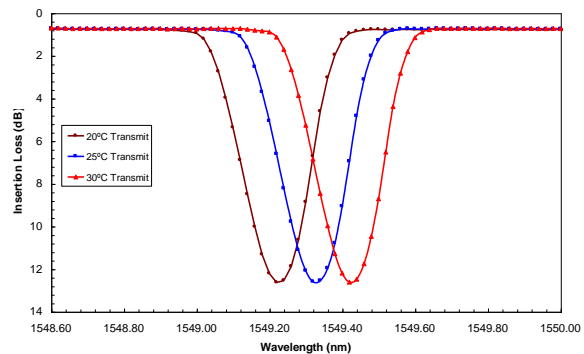


Basic DWDM test system

- Examination of channel add / drop and measurement of system crosstalk / channel isolation
- Examination of wavelength drift effects on DWDM System cross-talk
- Influence of system crosstalk on the Eye Diagram / BER in DWDM Systems (*requires BER(WDM)*)



Crosstalk effect on System BER



Bragg grating temperature response (transmission)

## BRAGG Ext:

- Bragg grating characterisation and spectral behaviour
- Examination of temperature tuning of a Bragg grating.
- Investigation of Bragg grating as a temperature sensor.

## Product Description

The OptoSci ED-WDM Series of educator kit modules consist of the following hardware elements (all component modules are housed in 3U 19" rack style units):

### WDM COMPONENTS:

- ITU Grid DFB laser module with integrated precision current and temperature driver. The front panel control allows tuning of the source over a range of  $\pm 0.8\text{nm}$  with 10pm resolution. The laser wavelength is displayed on an integral LCD display. A front panel SMB connector allows direct modulation of the source up to  $\sim 100\text{MHz}$ .
- Two SC connectorised InGaAs optical power meters with dBm power readout on integral LCD displays. Dynamic range  $\sim 60\text{dB}$ .
- Set of SC connectorised fibre component modules: Fused Biconical Taper (FBT) coupler, FBT WDM, isolator, circulator, OADM, fibre Bragg grating; PC & APC Connectors
- A 3U 19" rack enclosure for passive modules and all required interconnect fibre patchcords
- A 3U 19" rack enclosure with integrated power supply, USB interface, and all required electrical interconnects and RF cables.

### 1310/1550 WDM Ext:

- 1310nm laser module with integrated precision current and temperature controller with integral LCD display. A front panel SMB connector allows direct modulation of the source up to  $\sim 100\text{MHz}$ .
- SC connectorised FBT WDM component module, all additional interconnect fibre patchcords required
- 4km SC connectorised singlemode fibre reel
- Two SC connectorised InGaAs photoreceivers with BNC outputs. Receiver bandwidth  $\sim 100\text{MHz}$ , Max Input Power =  $-8\text{dBm}$  (fixed optical attenuators are supplied for high power inputs).

## DWDM Ext:

- One additional ITU Grid DFB laser module (adjacent ITU Channel to WDM COMPONENTS DFB) with integrated precision current and temperature driver. The front panel control allows tuning of the source over a range of  $\pm 0.8\text{nm}$  with 10pm resolution. The laser wavelength is displayed on an integral LCD display. A front panel SMB connector allows direct modulation of the source up to 100MHz.
- Two SC connectorised InGaAs photoreceivers with BNC outputs (*if not supplied already with 1310/1550 WDM Ext*). Receiver bandwidth  $\sim 100\text{MHz}$ , Max Input Power = -8dBm (fixed optical attenuators are supplied for high power inputs).
- SC connectorised OADM module, all additional interconnect fibre patchcords required
- Variable Optical Attenuator module with panel mounted control allowing up to 40dB attenuation.

## BRAGG Ext:

- SC connectorised fibre Bragg grating module with integrated Peltier thermoelectric device.
- Thermoelectric Controller Driver Module allowing front panel adjustment of set temperature (in  $0.1^\circ\text{C}$  increments). Integral LCD displays set and actual temperature.

## Additional required equipment:-

- Most experiments can be performed using the front panel controls on the instrument modules. However, external computer control and readout of the instrument modules using the driver software supplied will require a PC with USB support.

Performance of the full series of experiments in the DWDM Ext and 1310/1550 WDM Ext modules requires:

- A two channel digital storage oscilloscope (DSO) fitted with a USB output, minimum bandwidth of 50MHz, and (for the BER experiments) a minimum *real time* sampling rate of 500Msamples/sec (*contact OptoSci to confirm suitable DSO models*).
- A laboratory signal generator (up to 10V p-p output, frequency up to at least 2MHz, 10MHz preferable)
- **BER(WDM)**: Some DWDM & 1310/1550 WDM Systems experiments require a BER(WDM) module.

## Driver Software

- ED-WDM Series includes a CD with driver and display software (compatible with Windows OS from XP up to 10) to provide computer control / monitoring of the appropriate hardware modules via the instrument's USB interface.
- The driver software allows examination of light, voltage, current (LVI) characteristics of the ITU grid laser sources, and also allows automatic wavelength scanning of the laser sources and readout of optical power meters to enable narrowband characterisation of WDM components.
- The software includes a dedicated laser LVI and optical component Wavelength Scan plotter which can be viewed on screen. The data can also be saved in CSV format for export to spreadsheet packages.

## Literature

The comprehensive literature package supplied with the educator kit contains:-

- Student laboratory manual, describing the background theory and experimental procedure, with associated exercises to encourage the student to discuss the implications of their results.
- Instructor's manual dealing with all aspects of using the kit and providing sample results for the experiments and exercises and background notes on fibre optic components and WDM systems.

## Further Extensions

- **4-Ch.DWDM Ext** is an add-on to the DWDM Ext and includes additional ITU Grid DFB laser modules and DWDM components to assemble & investigate a 4-Channel DWDM system. Please contact OptoSci if you would like more details.
- Note that an Optical Spectrum Analyser (OSA) is not required for any ED-WDM Series experiments but could be used to examine WDM system and component response over a broader wavelength range.

## Ordering Information

WDM COMPONENTS	WDM Component Characterisation
BRAGG Ext	Bragg Gratings extension to WDM COMPONENTS
1310/1550 WDM Ext	1310/1550 WDM extension to WDM COMPONENTS
DWDM Ext	DWDM Systems extension to WDM COMPONENTS
BER(WDM)	BER Experiments for WDM (add-on module)
4-Ch.DWDM Ext	4-Channel DWDM add-on to DWDM Ext.

Since OPTOSCI are committed to continuously improving the design and performance characteristics of our products, these specifications are subject to change without notice.

Date: March 2018