

# Optical Transmission and Subsystems Laboratory

## Optical communication test and measurement equipment

AGILENT 8163 Lightwave Multimeter Mainframe:

- 81630B - High Power Sensor Module, 28dBm.
- 81571A - Optical Attenuator Module, angled.

AGILENT Infiniium DCA-J 86100C Wide-Bandwidth Oscilloscope Mainframe:

- 86100C-001 - Enhanced Trigger, 13GHz BW.
- 86100C-200 - Enhanced Jitter Analysis Software.
- 86105C - 9 GHz optical / 20 GHz electrical sampling module, 750 to 1650 nm - SMF and MMF.
- 86105C-200 - Multi 9G filters - 9.953 Gb/s, 10.3125 Gb/s, 10.518 Gb/s, 10.66 Gb/s, 10.709 Gb/s, 11.1 Gb/s, 11.3 Gb/s.
- 83496A - Clock Recovery Module.
- 83496A-101 - Optical and Electrical Inputs, 50 Mb/s - 7.1 Gb/s.
- 83496A-200 - Extend maximum rate from 7.1 Gb/s to 13.5 Gb/s.
- 83496A-300 - Adjustable Loop Bandwidth.

ANDO AQ6317C Optical Spectrum Analyzer.

EXFO EM 550 Fixed PMD Emulator.

EXFO FLS-5800 CD/PMD Analyzer Source.

EXFO FTB-400 Universal Test system:

- FTB-5500B - Polarization Mode Dispersion Analyzer.
- FTB-5800 - Chromatic Dispersion Analyzer.

EXFO IQS-500 Intelligent Test System:

- IQS-510P - Control Unit. Option N10 (standard 256 MB of memory)+ Option I3 (GPIO Card) + Option G1 (CD-ROM).
- IQS-1700 and OHS-1700 - High-Performance Power Meter (1 channel) and Optical Head.
- IQS-2600B - C+L-Band Tunable Laser Source.
- IQS-5100B - Polarization Controller.

NetTest TUNICS-Reference Tunable External Cavity Laser:

- Model SCL - S+C+L band over 1460-1610nm; up to 10dBm output power.
- Option M - Polarization maintaining output fiber.

PROMAX PROLITE-23 Optical Power Meter, with FC/PC connector.

PROMAX PROLITE-90 Dual Wavelength Laser Light Source, for 1310 nm and/or 1550 nm:

- Output connector FC/PC.
- AA-012 - Car lighter adapter.
- AL-013 - Mains adapter 230V/50-60Hz for Europe.
- CB-042 - Rechargeable battery 7.2V, 1500mAh.

Keysight DSOX2012A 100 MHz oscilloscope, with one N2862B 150 MHz 10:1 passive probe per channel.

TEKTRONIX CSA7404 Communications Signal Analyzer:

- 4 GHz bandwidth and 20 GSa/s real-time sampling rate option.
- P7330 - 3.5 GHz active differential probe.

TEKTRONIX AWG7122C Arbitrary Waveform Generator:

- AWG7122C Opt.01 - Waveform length expansion (32M points to 64M points).
- AWG7122C Opt.03 - Interleaved high bandwidth output.
- RFX100 - Base software RFXpress.
- RFX100 OFDM - RFXpress plug-in for Generic OFDM signal creation.

TEKTRONIX DPO72004C Digital Phosphor Oscilloscope:

- DPO72004C Opt.5XL - Extended record length (50M points/ch).
- DPO72004C Opt.SVE - SignalVU Essentials vector signal analysis software.
- DPO72004C Opt.SVM - General purpose digital modulation analysis.

DSC R401HG Linear PIN transimpedance amplifier in Lab Buddy (2 units), with SMA RF adapter and FC/APC connector.

MANLIGHT HWT-EDFA High Power Optical EDFA amplifier (2 units), with FC/APC connectors and +23 dBm output power.

YENISTA Optics 8-Channel modular platform:

- 3 TLS-AG-C band/M/A WDM tunable laser source modules, up to 90 channels in C or L band, and +13 dBm output power.

FINISAR Waveshaper 1000S Programmable Optical Filter, with 1x1 ports, FC/APC connectors, C-Band configuration, and WaveManager software.

FINISAR Waveshaper 4000S Programmable Optical Filter, with 1x4 ports, FC/APC connectors, C-Band configuration, and WaveManager software.

THORLABS PRO8000 8-Slot Modular Rack Chassis:

- LDC8001 - Laser Diode Current Module (2 units), with ±100 mA Max. LD current
- ITC8102 - Laser Diode Current and T control Module
- TED8040 - Temperature Control Card (2 units)

JDSU MTS 6000A with OTDR module.

### Optical, electro-optical and electrical devices

- PHOTLINE MXAN-LN-40 LiNbO3 Mach-Zehnder modulator (MZM) with a RF driver (DR-AN-40-MO), both up to 40 GHz bandwidth.
- U2t SCMO1120 Nested, fully integrated I/Q MZM, for advanced 40 Gb/s DQPSK transmission (20 Gbaud per channel), based on GaAs technology.
- PHOTLINE MPZ-LN-10 LiNbO3 phase modulator, up to 12 GHz bandwidth.
- PICOMETRIX P50A Ultrafast InGaAs PIN photodetector, with 50 GHz bandwidth, loaded with 50 Ohm, responsivity of 0.6 A/W at 1550nm.
- Mini-circuits RF amplifiers (some units), with 24 dB of Gain and flat response, 5-20 GHz bandwidth.
- Spinnaker Voltage controlled oscillator (VCO) VC1218B1, with frequency output from 12 to 18 GHz.
- U2t BPDV2120 waveguide-integrated balanced photo-detectors (4 pairs)
- SHF S807 Ultra-Linear modulator driver (8 units), 23-24 dB of Gain, bandwidth from 60-70 KHz to 40-55 GHz.
- FUJITSU LEIA DK C2 Digital to Analog Converter (DAC) with 4 channels, 55-65 GSa/s, 8-bit resolution, 2xIQ pairs, >13 GHz of output bandwidth, 8-bit x 256K samples of memory per channel.

- FINISAR M2000CB programmable (Pre/Booster) EDFA modules, with 15-25 dB programmable Gain, C-band, and up to 20 dBm output power.
- FUJITSU FTM7977HQA Ti:LiNbO3 DP-QPSK Single-Drive MZM, with 23 GHz bandwidth, comprising two QPSK modulators.
- EOSPACE Small-Form-Factor LiNbO3 intensity modulator, with 0-40 GHz bandwidth, X-cut and low Vpi.
- SUMICEM T.MXH1.5-40PD-ADC-LV Pulse carver LN Intensity modulator, with 40 GHz bandwidth, Zero chirp and Low Vpi.
- FUJITSU FTM7937EZ7202 Low Drive Voltage LiNbO3 MZM, 40 Gb/s NRZ, with differential Driver.
- BRIMROSE AMF-100-8-100-1550-2FP-SM and AMF-100-8-100-1550-2FP-NFS-SM Fiber-coupled Acousto-Optic Modulators (AOM), for 1550 nm, +100 MHz frequency shift and non-frequency shift, 100 nsec Rise time.
- BRIMROSE FFF-100-B1-F0.25-ER50-M and FFF-100-B1-F0.25-2RFI-ER50-M fixed frequency drivers.
- FINISAR CPRV2222A-LP integrated coherent receiver, 100 Gb/s DP-QPSK, 25 GHz O/E bandwidth at C-band, with evaluation board.
- BEOGOLD BG-Raman-SS-1450nm-10dB-25dBm-09SM-1m-FC/APC Raman Amplifier Module.
- THORLABS SOA1013S Semiconductor Optical Amplifier with evaluation board.
- AEON SAC20r-0-1-1 Semiconductor Optical Amplifier with evaluation board (2 units).
- THORLABS BDX1BA pair compact 5 GHz of Balanced Photodetectors with evaluation board.
- RIO Lasers RIO0075-3-34-4 ORION 1550.12nm Narrow Linewidth Laser Module.
- VCSELS of 10 Gb/s and 25 Gb/s

#### Optical and electrical passive components

- Fiber Optics Adapters, simplex and duplex, for different connectors.
- Fiber Optic Patch cords, of standard SM and PMF fibers of 1m, 2m, 3m, 5m and 10m, with different connectors.
- Standard G.652 SM fiber-optic spools, of 1, 2, 5, 10, 25 and 50 Km, with 0.19 dB/km of attenuation at 1550nm.
- KYLIA 002040 90° optical Hybrid, with two single polarizations, enabling to extract phase, amplitude and polarization from signal.
- 1x8 PLC power splitter, in LGX Cassette, G.657A1 fiber type, 1260-1650nm.
- Optical Attenuator of 1dB, 2dB, 3dB, 5dB, 10dB, and 15dB.
- 1x2, 2x2 SM optical couplers with 50/50, 10/90, 5/95 and 1/95.
- 45° Faraday rotators (2 units), from PMF to PMF in-line.
- Athermal arrayed waveguide gratings (AWG) of 40 Gaussian channels, 100 GHz grid (2 units).
- SM 19-core Multicore Optical Fiber (MCF), 25 Km length, multicore Fan-in Fan-out multiplexers with <4 dB IL.
- 3-ports circulators (2 units), 1550 nm, FC/APC connectors.
- O/E Land ADD/DROP Module, in athermal box with FBG and circulator (3 units).
- Polarization controllers (some units) of 3 independent fractional "wave plates".
- Polarization Beam Combiners (PBC)/Splitters (PBS), at 155 nm, some units with SM and PM.
- 50 Ohm cable assemblies with different lengths (up to 1.5 m), material characteristics (hand-formable, semi-rigid or flexible), frequency range (from DC to 12.4, 13, 18, 26.5, 40 or 60 GHz), and with different terminations.

- Double-balanced mixers (some units), with IF port up to 10 GHz, and LO/RF ports from 9 to 20 GHz.
- SHF BT45R-D Bias Tee (2 units), with 20 KHz-45 GHz bandwidth.
- Mini-circuits 2 way-0° power splitter, from DC to 18 GHz.
- Various RF adapters up to 40 GHz.
- RF attenuators from 3 to 20 dB, with frequency range either up to 18 GHz or up to 26 GHz.
- Several loads (50 Ohm) DC blocks and low-pass filters (5GHz and 7.2GHz).
- Test and measurement cables (red and black with different terminations).

**Equipment for implementation of optical transmission subsystems and experimental setups**

- THORLABS NEXUS T1525C optical table with passive isolation system, 1.5 m x 2.5 m x 210 mm surface, and M6 mounting holes with metric disposition.
- AGILENT/KEYSIGHT E3646A Dual output DC power supply with dual range (3 units): 0-8V/3A and 0-20V/1.5A
- PROMAX FA-665 Triple DC power supply (4 units), with two main outputs (0 to 30V/5A), and one auxiliary output (5V/1A).
- FLUKE 189 DC+AC RMS multimeter with 100 KHz AC bandwidth.
- JDSU Mini video microscope with camera and 1.8" TFT display (2 units), 200X of magnification.
- O.C. White Co. ProZoom PZT-6.5 Microscope with Led Ring light and Camera.
- THORLABS MAX312D/M 3-Axis NanoMax Stage with Fixed Differential Drives
- THORLABS KNA-IR K-Cube NanoTrak Fiber Fiber Alignment Controller.
- Precision fiber cleaver for fibers from 80um to 200um.
- VPI Photonics software (2 licenses), one with QKD toolkit.