OVNA-P100X

20/40 GHz Optical Vector Network Analyzer

ephoox
PHOTONICS ENGINEERING

20/40 GHz Test System for Optical RX and TX

Opto-Electronic S-parameter measurements

The Ephoox OVNA P100-X upgrades the functionality of an vector network analyzer (VNA), enabling it to carry out measurements and characterization of the S-parameters of a variety of components and devices such as electro-optic modulators (EOMs), optical amplifiers, radio over fiber subsystems (RoF subsystems) and any other passive or active, photonic, opto-electronic or electro-optical devices and systems.

This external instrument is compatible with VNAs from any manufacturer. It features a modulation bandwidth of 20/40 GHz and is ready for using either fixed (centered @ 1550 and 1310 nm) or tunable optical sources.

Key Features

- Operation frequency up to 40 GHz
- Available for 1550 and 1310 nm
- Internal optical source and external optical input
- High OMI efficiency
- Two receivers for low and high power optical inputs
- Protection system for electronic and optical internal components

Applications

- Transmission system test
- Components characterization
- Receiver frequency test
- R&D laboratories

Measurement Capabilities

The main measurement capabilities are the following:

- 3 dB cut-off frequency (S21)
- Responsivity (S21)
- Electrical reflection (S11 or S22)
- Group Delay vs. frequency
- Insertion Loss (IL)
- Transmission bandwidth
- All electrical S-parameter measurements

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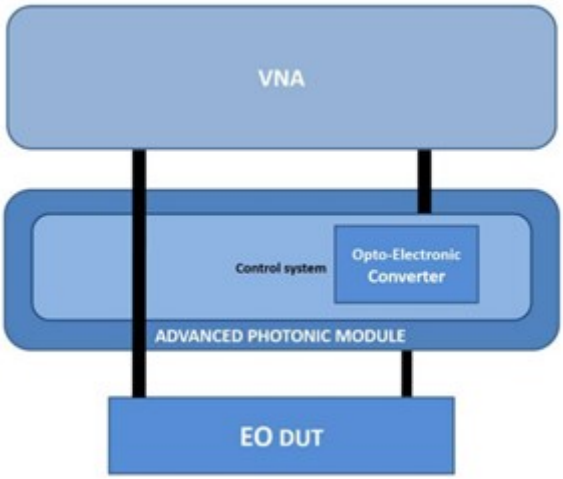
Target test devices

Advanced optical and electrical components, both transmitters and receivers, can be tested and characterized in frequency, phase, losses and power levels, among others parameters, by OVNA-P100X. The innovative architecture allows multiple set-ups for testing all kind of opto-electric devices, available configurations are described below.

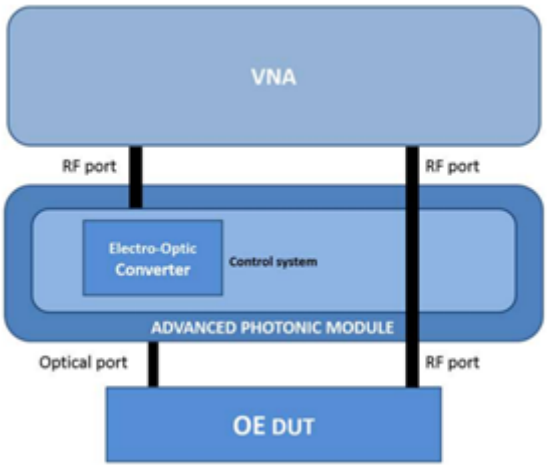
Electronic-Optical (EO) Configuration

This setup can be used, for instance, for determining frequency and phase response of electro-optic, acousto-optic and electro-absorption modulators, laser modulation transfer functions, Mach-Zehnder modulators, RoF links and systems, etc. The transmitter (DUT) is connected to the VNA RF port and the opto-electronic conversion is performed by the Rx stage of OVNA -P100X.



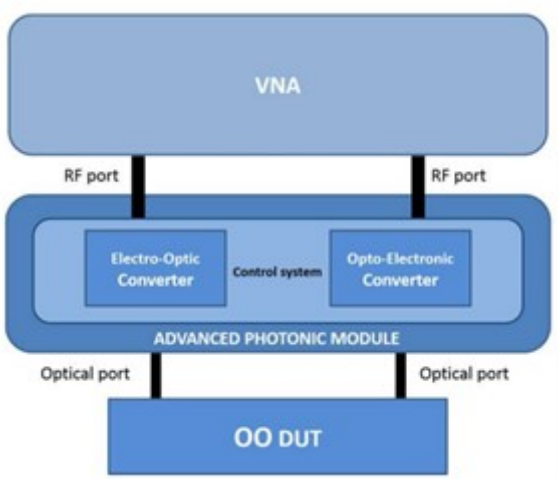
Optical-Electronic (OE) Configuration

This option is useful, for instance, in the characterization of the Responsivity of photodetectors such as PIN Diodes or APD's, receiver optical subassemblies (ROSA) and integrated PIN-TIA receivers. The receiver (DUT) is connected to the electro-optic converter from Tx stage of OVNA-P100X and to the VNA RF port.



Optical-Optical (OO) Configuration

Finally, this configuration allows for the S-Parameter characterization of photonic components, such as optical attenuators, delay lines, dispersive fiber links, couplers, WDM multiplexers and demultiplexers and optical amplifiers as EDFAs and SOAs among other optical devices. Both electro-optic and opto-electronic conversion are performed by OVNA-P100X, which is interconnected to the VNA equipment.



Complete interoperability with market VNAs

OVNA-P100X approaches a complete combined solution composed of a Vector Network Analyzer (VNA) and an advanced photonic module. It also shows the key features and performance of this advanced photonic module. The advanced photonic module is compatible with any VNA from any manufacturer in the market. The communication between the VNA and the optical instrument is performed using LAN connection employing the respective ports, without penalizing the performance of the VNA.

Hence, the OVNA-P100X must be integrated with a VNA to provide the OVNA solution. The software in the photonic module will control the whole system and therefore this integration must carried out by ePhoox, being possible to integrate more than just one VNA.

The VNA model(s) that will be used must be detailed to us in order to consider the optimum type of integration that should be made.

Protection system for electronic and optical internal components

In order to guarantee the safety of internal devices and subsystems of the instrument, a protection system is implemented in the instrument. Warnings and messages will be shown in the visual user interface that will help the user to proceed correctly in the configuration process of a measurement in case of a wrong procedure.

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Key Specifications

Transmitter Wavelength
1550 nm ± 20 nm
1310 nm ± 20 nm
1260 nm to 1650 nm with external source

Integrated Transmitter and receiver power meter
For fast transmitter and DUT power verification and indication of breaks, bends and bad connections

External optical source input
PMF input, connects external laser source through a PMF optical switch to the internal modulator.

Selectable output power of the transmitter
Most DUTs need to be characterized at various average optical power levels. In this case it is necessary to set the average input power of the DUT to the desired value. This feature is offered by the OVNA P100-X achieving an extremely wide dynamic range with internal control by the user.

General Specifications

Setup conditions

- Electrical output power = -1 dBm
- IFBW[1] = 100 Hz
- Two-port electrical calibration, at constant temperature (± 1°C) with network analyzer is implemented
- Modulation-bias optimization set to “periodically”
- Specified temperature range = +20 °C to +28 °C
- Warm-up time of 90 minutes
- Internal lasers as optical source
- All values of this pre-specifications are typical
- No averages considered
- Using Keysight N5245A PNA-X Network Analizer

[1] IFBW set to 10Hz in a noise floor measurement

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Connector Type	
Optical source input	FC-APC / Polarization Maintaining Fiber
Optical output	FC-APC / Polarization Maintaining Fiber
Optical input	FC-APC / Single Mode Fiber
RF ports	1.85mm male
Maximum safe input level at port A or B	+20 dBm

Optical Tx Specs	
Optical modulation index (OMI)	>27% @ +5 dBm RF Power >47% @ +10 dBm RF Power
Output wavelength	(1310 ± 20) nm (1550 ± 20) nm
Average output power range	-40[1] dBm to +3 dBm -40[1] dBm to +0 dBm
Average output power stability (typical)	± 0.25 dBo
Average output power stability, 15 min (typical)	± 0.1 dBo

[1]Using attenuator option

Optical Rx Specs	
Wavelength range	1260 nm to 1650 nm
Maximum optical input power	(Optical input L: +7 dBm Optical input H: +17 dBm
Power measurement range	Optical input L: -60 dBm to +7 dBm Optical input H: -50 dBm to +17 dBm
Average power measurement uncertainty (typical)	± 0.1 dB

External Optical Source Input (-E)	
Recommended optical input power	+3 to +16 dBm
Optical input power damage level	+17 dBm
Typical loss at quadrature bias point	8.5 dB
Operating wavelength range	1260 nm to 1650 nm

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Operating Conditions

Operation frequency range	OVNA P100-X-40: 10 MHz to 40 GHz OVNA P100-X-20: 10 MHz to 20 GHz
Operating temperature	+10°C to +35°C
Storage temperature	-40 °C to +65°C
Temperature range	+20°C to +26°C

Frequency Response Uncertainty

		DUT response	0.010GHz 1GHz	1GHz 5GHz	5GHz 10GHz	10GHz 20GHz	20GHz 40GHz
1310	E/O	-25 dB (W/A)	±0.35 dBe	±0.35 dBe	±0.35 dBe	±0.40 dBe	±0.45 dBe
	O/E	-30 dB (A/W)	±0.30 dBe	±0.30 dBe	±0.30 dBe	±0.30 dBe	±0.35 dBe
	O/O	-3 dBo	±0.50 dBe	±0.50 dBe	±0.50 dBe	±0.50 dBe	±0.60 dBe
1550	E/O	-25 dB (W/A)	±0.20 dBe	±0.20 dBe	±0.30 dBe	±0.30 dBe	±0.30 dBe
	O/E	-30 dB (A/W)	±0.30 dBe	±0.25 dBe	±0.25 dBe	±0.25 dBe	±0.30 dBe
	O/O	-3 dBo	±0.25 dBe	±0.25 dBe	±0.25 dBe	±0.25 dBe	±0.30 dBe

Phase Uncertainty

		DUT response	0.010GHz 1GHz	1GHz 5GHz	5GHz 10GHz	10GHz 20GHz	20GHz 40GHz
1310	E/O	-25 dB (W/A)	±0.3°	±0.5°	±0.8°	±1.5°	±3.2°
	O/E	-30 dB (A/W)	±0.1°	±0.5°	±1.0°	±1.7°	±4.0°
	O/O	-3 dBo	±0.1°	±0.4°	±0.6°	±1.1°	±2.1°
1550	E/O	-25 dB (W/A)	±0.3°	±0.5°	±0.8°	±1.5°	±3.5°
	O/E	-30 dB (A/W)	±0.1°	±0.3°	±0.4°	±0.8°	±2.0°
	O/O	-3 dBo	±0.1°	±0.2°	±0.5°	±0.7°	±1.5°

Noise Floor

		0.010GHz 1GHz	1GHz 5GHz	5GHz 10GHz	10GHz 2 0GHz	20GHz 40GHz
1310	E/O	-85 dB(W/A)	-88 dB(W/A)	-87 dB(W/A)	-86 dB(W/A)	-82 dB(W/A)
	O/E	-105 dB(A/W)	-108 dB(A/W)	-107 dB(A/W)	-105 dB(A/W)	-100 dB(A/W)
	O/O	-74 dBe	-78 dBe	-77 dBe	-74 dBe	-67 dBe
1550	E/O	-96 dB(W/A)	-98 dB(W/A)	-98 dB(W/A)	-96 dB(W/A)	-91 dB(W/A)
	O/E	-105 dB(A/W)	-107 dB(A/W)	-106 dB(A/W)	-104 dB(A/W)	-99 dB(A/W)
	O/O	-74 dBe	-78 dBe	-77 dBe	-74 dBe	-67 dBe

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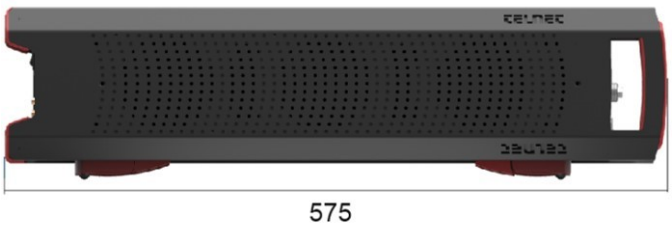
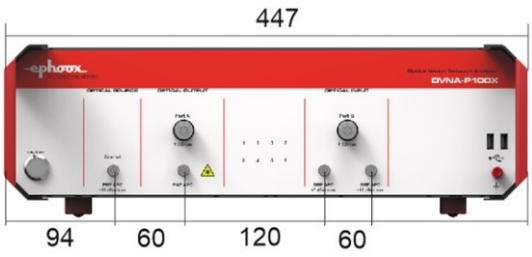
Frequency Response Repeatability							
		DUT response	0.010GHz 1GHz	1GHz 5GHz	5GHz 10GHz	10GHz 20GHz	20GHz 40GHz
1310	E/O	-25 dB (W/A)	±0.04 dBe	±0.05 dBe	±0.07 dBe	±0.10 dBe	±0.20 dBe
	O/E	-30 dB (A/W)	±0.02 dBe	±0.02 dBe	±0.02 dBe	±0.03 dBe	±0.05 dBe
	O/O	-3 dBo	±0.04 dBe	±0.04 dBe	±0.04 dBe	±0.04 dBe	±0.10 dBe
1550	E/O	-25 dB (W/A)	±0.04 dBe	±0.04 dBe	±0.05 dBe	±0.06 dBe	±0.10 dBe
	O/E	-30 dB (A/W)	±0.03dBe	±0.03 dBe	±0.04dBe	±0.04 dBe	±0.05 dBe
	O/O	-3 dBo	±0.03 dBe	±0.03 dBe	±0.03 dBe	±0.04 dBe	±0.06 dBe

General info

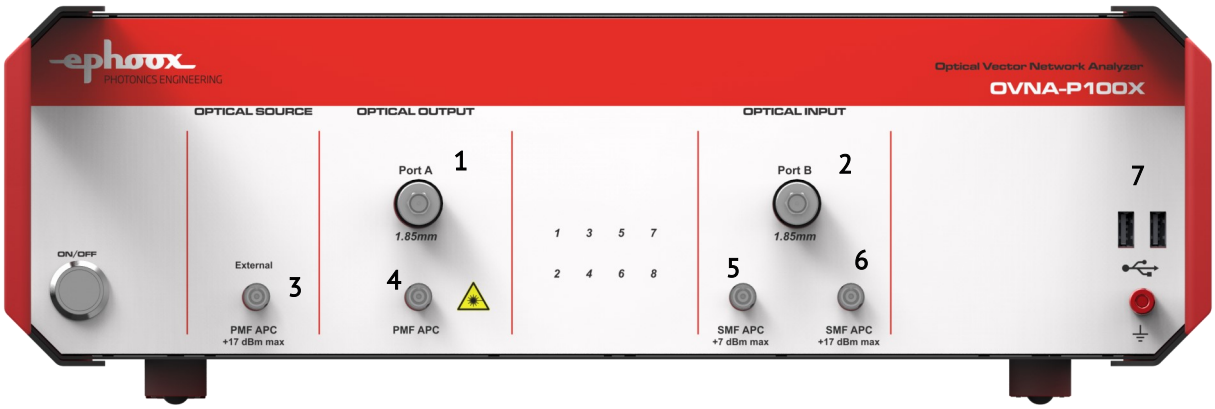
Dimensions and others	
Dimensions (Length x Width x Height) [mm]	575x447x258
Weight [kg]	17
Control system	Windows desktop (miniPC) + User Application + Remote management (Ethernet)





Panel Connections

The OVNA-P100x presents an integrated compact design, which allows to configure easily different setups for any of the possible test cases (EO, OE and OO DUTs) thanks to the set of interfaces and ports available on the equipment. The figure below shows all OVNA interfaces to interconnect the equipment with opto-electronic devices (DUTs), VNAs, storage devices, several peripherals and power supply.



1. RF INPUT PORT
2. RF OUTPUT PORT
3. EXTERNAL SOURCE INPUT
4. OPTICAL OUTPORT
5. LOW LEVEL OPTICAL INPUT
6. HIGH LEVEL OPTICAL INPUT
7. USB 3.1 PORTs

A. PS/2 PORT
B. USB PORTS
C. HDMI PORTS
D. RJ45 PORTs
E. USB PORTs
F. RF SMA CONNECTORs
G. JACK PORTs (PERIPHEALs)
H. POWER SUPPLY

The following table describes the complete list of items

Connector Type	Location	#	Usage
USB 2.0 - Type A Female	Back	2	Storage/Peripherals
USB 3.1 - Type A Female	Back Front	4 2	Storage/Peripherals
RJ45 Ethernet 10/100/1000	Back	2	LAN and WAN Connectivity
Power Supply Connector 220VDC	Back	1	Power Supply
RF COAXIAL 65GHz Connector	Front	2	VNA Connection
Optical FC/APC Ports	Front	4	DUT Connection
HDMI Outport	Back	1	Screen Monitor
Display Outport	Back	1	Screen Monitor
PS/2 Port	Back	1	Mouse/Keyboard
RF SMA Connector	Back	2	WiFi
Female Jack Connector	Back	6	Peripherals

Setup Configuration

Ports #1 and #2 are available to connect the OVNA-P100X with the corresponding VNA equipment, whilst ports #4, #5 and #6 belongs to the optical stage. Port #3 allows to insert an external laser source to perform tests in different wavelength ranges (Internal sources – Port #4 is fixed to 1310nm or 1550nm). The selection between the two optical inputs (#5 and #6) depends on the optical power level that provides the DUT. The table below indicates port connections for the different setup configurations:

TEST Setup	OVNA Transmitter	OVNA Receiver
EO DUT	N/A	FC/APC Connector to Port #5 or #6
OE DUT	FC/APC Connector to Port #4	N/A
OO DUT	FC/APC Connector to Port #4	FC/APC Connector to Port #5 or #6

To complete OVNA-P100X setup is necessary to configure the network interfaces. There are two RJ-45 ports for connecting the system with VNA network (compulsory) and with WAN (optional). Both interfaces must have their own subnet (IP Address – Masknet) according to the VNA subnet and to the WAN. Note that OVNA-P100X includes a Windows-based miniPC with a standard OS desktop, configure networking setup in network adapter options menu. Finally, run OVNA User App for communicating with the VNA.

VNA Integration

The OVNA-P100-X must be integrated with a VNA to provide the OVNA solution. The software in the photonic module will control the whole system and therefore this integration must be carried out by Ephoox, being possible to integrate more than just one VNA.

The VNA model(s) that will be used must be detailed to us in order to consider the optimum type of integration that should be made. It is a must to have registered and uploaded the VNA model and its specifications in the OVNA user desktop application. Ephoox will update its current VNAs repository in order to include the new VNA profiles in case of not existing. This procedure is totally viable in a remote way. Compatibility is guaranteed by Ephoox.

Calibration Module

Each OVNA-P100X has its manufacturing calibration procedure. This process is also carried out by Ephoox as the VNA integration methodology. The cost of the calibration service is included within OVNA product quotation.

Ordering Information

OVNA Options	
OVNA-P100-X-20-APC/PC	10 MHz to 20 GHz
OVNA-P100-X-40-APC/PC	10 MHz to 40 GHz

It is necessary to choose between APC and PC connectors. We recommend APC connectors since it is for this type of connectors that pre-specifications on this datasheet are guaranteed.

Optical source options	
-E	External optical source 1310/1550
-13	1310 nm internal optical source
-15	1550 nm internal optical source

Warranty

OVNA-P100X includes a one-year warranty by default and it is possible to extend this warranty up to 3 or 5 years.

About Us

Ephoox Technology is a spin-off company from the Photonics Research Laboratory at iTEAM (Valencia). Its mission is to provide innovative solutions based on Microwave Photonics technology for 5G telecommunications as well as for other emerging application fields, including avionics, autonomous driving and the Internet Of Things. Its vision is to become a world-leading company in developing and providing solutions based on last generation Microwave Photonics technologies. Ephoox develops the only available broadband Optical vector Network Analyzer overlay equipment compatible with most of the existing RF Vector Network Analyzers.

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Definitions

General

Product data applies under the following conditions:

- Three hours storage at ambient temperature followed by 90 minutes warm-up operation.
- Specific environmental conditions met.
- Internal automatic adjustments performed.

Typical data (typ.)

Characterizes product performance by means of representative information for the given parameter. When marked with or as a range, it represents the performance met by approximately 80 % of the instruments at production time. Otherwise, it represents the mean value.

Nominal values (nom.)

Nominal values (nom.) characterize product performance by means of a representative value for the given parameter (e.g. nominal impedance). In contrast to typical data, a statistical evaluation does not take place and the parameter is not tested during production.

Measured values (meas.)

Measured values (meas.) characterize expected product performance by means of measurement results gained from individual samples.

Uncertainties

Uncertainties represent limits of measurement uncertainty for a given measurement. Uncertainty is defined with a coverage factor of 2 and has been calculated in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM), taking into account environmental conditions, aging, wear and tear.