Keysight Technologies
M8290A Optical Modulation Analyzer and High-Speed Digitizer Test Solution

Data Sheet



KEYSIGHT TECHNOLOGIES

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M8290A Modular Coherent Test Solution

Optical coherent transmission technology, initially used in long-haul transmission, is evolving into metro networks and expanding to data center interconnects. Each product generation increases transmission speed by moving to higher symbol rates and higher-order QAM constellations. Today's 100G systems that use quadrature phase shift keying (QPSK) at 32 GBd will evolve to 400G by doubling both the bits per symbol and the symbol rate; i.e., using 16-state quadrature amplitude modulation (16QAM) at 64 GBd.

At the same time, the industry's target is to reduce size, cost, and power consumption of the transceiver hardware. Higher complexity transmission schemes, combined with new challenges that result from dense electronic and photonic integration, lead to tighter requirements and lower performance margins for all components as well as the assembled transceivers. Increasing data throughput while reducing size, cost and power consumption requires rigorous testing during development, NPI, and production phases.

The M8290A rack-mountable modular coherent test system for the AXIe platform addresses the 400G speed class in a significantly narrower form factor and a more attractive price point than today's oscilloscope-based solutions for this speed class.

For coherent transmitter and receiver testing, the M8292A compact optical modulation analyzer and M8296A high-speed digitizer fill the gap between the portable N4392A integrated optical modulation analyzer for 100G and the real-time oscilloscope-based N4391A optical modulation analyzer supporting speed classes of 400G, 600G and 1 Terabit per second.

The compact and modular approach makes the M8290A optical modulation analyzer and high-speed digitizer test solution an ideal system for coherent transmitter signal qualification for EVM and related parameters as well as for coherent optical device characterization including assemblies like ICR, PMQ, CDM, IC-TROSA or ACO. The modular concept addresses the needs of development teams, new product introduction groups and production test engineers looking for affordable test equipment for 400G. The M8290A optical modulation analyzer and high-speed digitizer test solution provides a combination of compactness, affordability and performance that cannot be achieved with current oscilloscope-based solutions in this speed class.



Figure 1. Configuration with optical and electrical modules (left), and configuration with electrical module only (right).

In the M8290A system configuration, the M8292A optical modulation analyzer module (a 2-slot AXIe module) and a 4-channel single-slot electrical digitizer module are available, both operating at 92 GSa/s sampling rate.

A 5-slot AXIe chassis has room to plug in an additional electrical source module like the M8195A or M8196A arbitrary waveform generator. The modular architecture enables stimulus and analyzer capabilities in one mainframe to form a very compact stimulus-response test solution at an unmatched price/performance level.

Turn-key ICR Test Solution

Integrated Coherent Receiver (ICR) modules are key components in coherent transmission systems and are more challenging to test than direct-detection receiver optical sub-assemblies (ROSAs), as the ICRs have phase-sensitive signal detection and provide four electrical outputs and two optical inputs. The test instruments used in ROSA S21 testing cannot be used in a similar way for S-parameter testing of ICRs, making S-parameter testing very challenging.

To help users set up S-parameter tests for ICRs in significantly less time than developing their own solution, the M8290A provides an optionally-available ICR test software that measures:

- S21 magnitude responses
- IQ skew, XY skew
- IQ angle
- IQ and XY gain imbalance
- EVM noise floor
- Image suppression

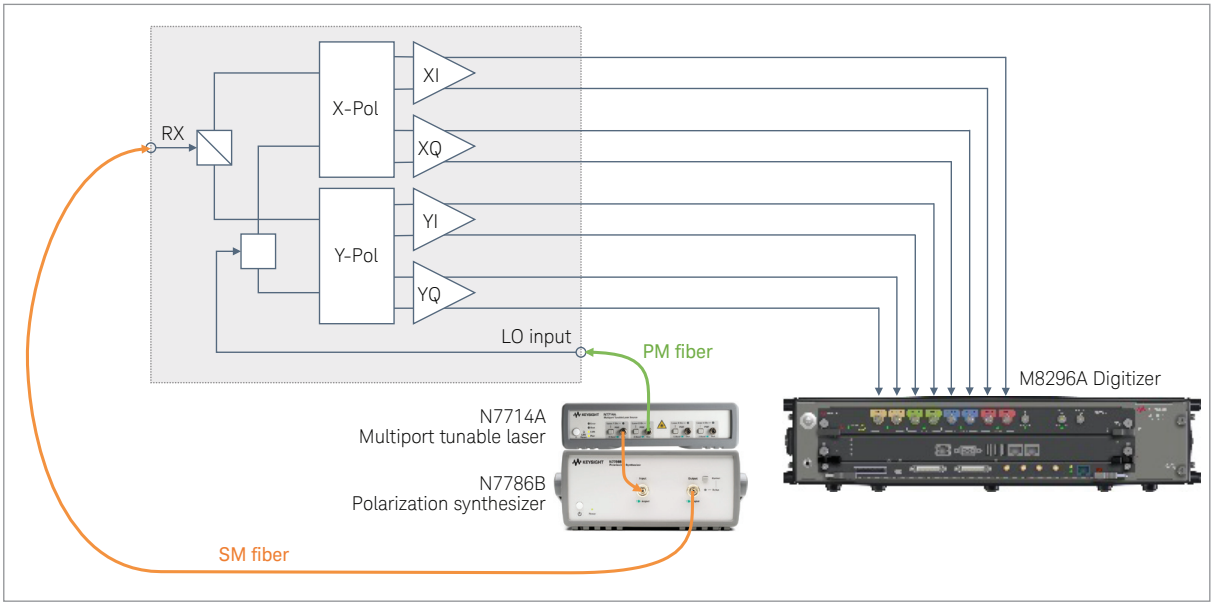


Figure 2. Test setup for ICR modules

Test Solution for Coherent Optical Transmit & Receive Devices

Coherent optical devices such as dual-polarization IQ modulators and intradyne coherent receivers need to be tested in their different development stages as well as qualified by the system integrators.

The optionally available coherent optical device test software provides a turn-key solution for the characterization of these devices. One user interface provides control of all instruments through a single software package. None of the tests requires reconnecting the DUT, saving test time and reducing the uncertainty introduced by connecting and reconnecting the device. The coherent optical device test license provides:

- S21 magnitude and phase responses
- IQ skew, XY skew

The setup can be customized in three different ways for transmit device testing, receive device testing and sequential testing of both, transmit and receive devices. Furthermore, it can be extended to perform system-level tests as well as wavelength and power calibration of the laser.

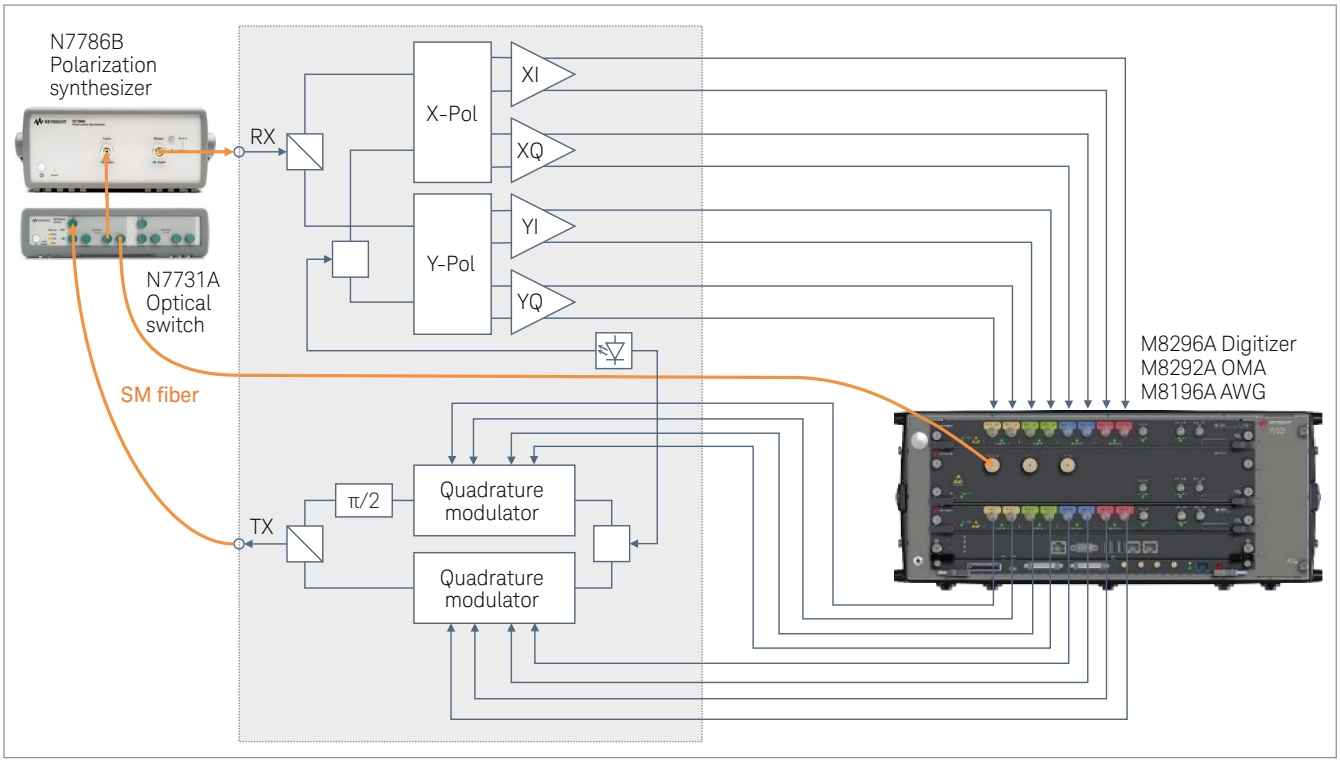


Figure 3. Example test setup for coherent optical transmit & receive devices.

M8292A Modular Optical Modulation Analyzer Specifications

Table 1. M8292A Modular Optical Modulation Analyzer specifications

M8292A Modular optical modulation analyzer	Typical values
Maximum detectable symbol rate	74 GBd
Sample rate range	83 to 92 GSa/s
Maximum record length per channel	512 kSa[1]
ADC resolution	8 bit
Operating frequency range[4]	1 MHz to 40 GHz
Analog bandwidth, uncorrected	37 GHz (3 dB)
Optical wavelength operating range	1527.60 to 1570.01 nm (196.25 to 190.95 THz)
Average input power monitor accuracy	±0.4 dB
Optical phase angle of I-Q mixer after correction	90° ±0.5°
Relative skew after correction	< ±1 ps
Image suppression[5]	> 30 dB
Error vector magnitude noise floor	< 2.4% EVM rms at 2.5 GHz freq. offset[5] < 3.5% EVM rms at 10 GHz freq. offset[6]
Sensitivity[2]	–20 dBm –14 dBm (with Option 800)
Internal local oscillator (built-in)	
Wavelength settling time	< 30 s
Wavelength uncertainty	±4.5 pm (±560 MHz), guaranteed ±2.5 pm (±310 MHz), typical
Sidemode Suppression Ratio (SMSR)	≥50 dB
Relative Intensity Noise (RIN)[3]	–145 dB/Hz (10 MHz to 40 GHz)
External local oscillator input and output (Option 800)	
LO input wavelength range	1527.60 to 1570.01 nm
LO input power range	–3 dBm to +17 dBm
LO output power	> +9 dBm

1. 128 samples are unavailable, resulting in 511872 samples per channel effectively available.
2. Valid at EVM = 32.5% for 32 GBd DP-QPSK corresponding to raw BER = 1E-3, boost mode off.
3. At maximum laser power.
4. Adjusted baseband frequency range available for signal analysis.
5. Valid at the following reference conditions
   - Sampling rate 92 GSa/s
   - Optical continuous wave signal at optical input port
   - Signal power > 0 dBm
   - Optical frequency is offset by 2.5 GHz from local oscillator frequency
   - Vector analyzer I-Q spectrum span set to 12.5 GHz
   - QPSK demodulation
   - 10 GBd symbol rate
   - PolStokesAlign set to “Single Polarization”
   - KFPhaseTrack with carrier phase variance set to 1E-4
   - Result length set to 500 symbols
   - Raised cosine filter selected as reference filter
   - 25° C ±5 K environmental temperature
6. Valid at reference conditions as stated above, except for:
   - Optical frequency is offset by 10 GHz from local oscillator frequency
   - Vector analyzer I-Q spectrum span set to 50 GHz
   - 40 GBd symbol rate

M8292A Modular Optical Modulation Analyzer Specifications (continued)

Trigger input	Typical value
Input range	–4 V to +4 V
Threshold	
Range	–4 V to +4 V
Resolution	10 mV
Sensitivity	100 mV
Polarity	Selectable: positive, negative, either edge
Timing uncertainty	≤8 ns
Reference clock input	
Input frequency range	10 MHz to 17 GHz
Amplitude range	500 mV_{pp} to 2 V_{pp}
Impedance	50 Ω (nominal)
Connector type	SMA (female)
Reference clock output	
Frequency with respect to sample rate	f_{Sa} / 512
Amplitude	0.9 V_{pp} (nominal)
Impedance	50 Ω (nominal)
Connector	SMA (female)

Table 2. M8292A maximum ratings

Maximum ratings	
Maximum signal input power	+14.5 dBm
Signal input damage level	+15 dBm
External LO input power	
Maximum	+17 dBm
Damage level	+18 dBm
Reference clock input damage level	3 V_{pp}

Laser safety information



All laser sources listed above are classified as Class 1M according to IEC 60825-1/2014.
All laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated 2007-06-24.

M8296A Electrical High-Speed Digitizer Specifications

Table 3. M8296A electrical high-speed digitizer specifications

M8296A Electrical high-speed digitizer	**Typical value**
Maximum detectable symbol rate	74 GBd
Sample rate range	83 to 92 GSa/s
Maximum record length per channel	512 kSa[1]
ADC resolution	8 bit
Operating frequency range[2]	50 kHz to 42 GHz
Analog bandwidth, uncorrected	37 GHz (3 dB), guaranteed[3]
Skew between different input channels	< ±250 fs
Skew between normal and complement	< ±1 ps
Input amplitude ranges	150 $mV_{pp,diff}$ 300 $mV_{pp,diff}$ 500 $mV_{pp,diff}$ 800 $mV_{pp,diff}$
Input impedance	50 Ω (nominal)
Number of input channels	4
Trigger input	
Input range	–4 V to +4 V
Threshold	
Range	–4 V to +4 V
Resolution	10 mV
Sensitivity	100 mV
Polarity	Selectable: positive, negative, either edge
Timing uncertainty	≤8 ns
Reference clock input	
Input frequency range	10 MHz to 17 GHz
Amplitude range	500 mV_{pp} to 2 V_{pp}
Impedance	50 Ω (nominal)
Connector type	SMA (female)
Reference clock output	
Frequency with respect to sample rate	f_{Sa} / 512
Amplitude	0.9 V_{pp} (nominal)
Impedance	50 Ω (nominal)
Connector	SMA (female)

1. 128 samples are unavailable, resulting in 511872 samples per channel effectively available.
2. Adjusted baseband frequency range available for signal analysis.
3. Determined from a 9th order polynomial fit to the measured amplitude response.

Table 4. M8296A maximum ratings

Maximum ratings	
Damage level (single ended)	0.9 V_{pp} / 3 VDC
Damage level	3 V_{pp}

General Characteristics

Table 5. General characteristics

	M8292A **Modular 92 GSa/s optical modulation analyzer**	**M8296A** **Modular 92 GSa/s 4-channel electrical high-speed digitizer**
Dimensions (W x H x D)	322.25 mm x 60 mm x 281.5 mm	322.25 mm x 30 mm x 281.5 mm
Weight	3.6 kg	3.3 kg
Storage temperature range	–40° C to +70° C	
Operating temperature range	+5° C to +35° C	
Humidity	15% to 80% relative humidity, non-condensing	
Operating altitude	0 to 2000 m	
Power consumption	100 W at 92 GSa/s	
Safety designed to	IEC61010-1, UL61010, CSA22.2 61010.1 tested	
EMC tested to	IEC61326-1	
Form factor	2-slot AXIe	1-slot AXIe
Warm-up time	30 minutes	
Recommended re-calibration interval	2 years	
Shipping contents		
	1 x Optical modulation analyzer module M8292A	1 x 4-channel electrical digitizer module M8296A
	1 x 81000xI FC/APC connector interface (3 x 81000xI for option 800)	
	1 x UK6 report	1 x UK6 report
	1 x getting started guide for the M8290A	1 x getting started guide for the M8290A
	1 x RoHS addendum for photonic test and measurement products 9320-6654	1 x RoHS addendum for photonic test and measurement products 9320-6654
	1 x calibration certificate	1 x calibration certificate
	1 x entitlement certificate for M8290400A software package	1 x entitlement certificate for M8290400A software package
Connectors		
Signal input	9 µm single-mode angled 81000xI connector interface	2.4 mm (female)
Local oscillator input and output	9 µm single-mode angled 81000xI connector interface	n/a
Trigger input, reference clock input and output	SMA (female)	

Definitions

Generally, all specifications are valid at the stated operating and measurement conditions and settings, with uninterrupted line voltage and in "normal mode" (boost mode off).

Specifications (guaranteed)

Describes warranted product performance that is valid under the specified conditions. Specifications include guard bands to account for the expected statistical performance distribution, measurement uncertainties changes in performance due to environmental changes and aging of components.

Typical values (characteristics)

Characteristics describe the product performance that is usually met but not guaranteed. Typical values are based on data from a representative set of instruments.

General characteristics

Give additional information for using the instrument. These are general descriptive terms that do not imply a level of performance.

Configure Your M8290A Coherent Test Solution

Step 1: Choose OMA and digitizer modules

Table 6. Module selection

M8290A modules	Description
M8292A	Modular 92 GSa/s optical modulation analyzer, 2-slot AXIe
M8296A	Modular 92 GSa/s digitizer, 1-slot AXIe
Optional modules (orderable as separate items)	
M8195A	65 GSa/s arbitrary waveform generator, 1-slot AXIe
M8196A	92 GSa/s arbitrary waveform generator, 1-slot AXIe

Step 2: Select appropriate chassis

Table 7. Chassis selection

Chassis	Description
M9502A	2-slot AXIe-1 mainframe
M9505A	5-slot AXIe-1 mainframe
Controller (mandatory)	
M9537A[1]	Embedded controller, 1-slot AXIe

1. Please reserve one slot for the embedded controller.

Step 3: Add required and optional software

Table 8. Software selection

Software (mandatory)	Description
M8290400A	Optical modulation analyzer software
89601B-200	Basic vector signal analysis and hardware connectivity, transportable license[1]
89601B-AYA	Vector modulation analysis, transportable license[1]
Software add-ons (optional)	
M8290430A	ICR test license
M8290440A	Coherent optical device test license
89601B-BHF	Proprietary and pre-standard OFDM formats
89601B-BHK	Proprietary and pre-standard, customized IQ constellation signals.
81195A	Optical modulation generator software

1. Other license models are available. For details, see https://www.keysight.com/de/de/software/application-sw/89600-vsa-software/family-options.html

Keysight Support Services

Accelerate your learning curve, enhance your test uptime, and confidently guarantee your instrument accuracy with Keysight Support Services. Keysight Services are here to support your test needs with expert technical support, instrument repair and calibration, training, alternative acquisition program options, and more.

A KeysightCare agreement provides dedicated, proactive support through a single point of contact for an extensive group of instruments, software, and solutions to ensure optimal uptime, with fast response times and resolution. Explore the services that are right for you.

Keysight Services

Offering	Benefits
KeysightCare 	KeysightCare provides elevated support for Keysight instruments and software, with access to technical support experts who respond within a specified time and ensure committed repair and calibration turnaround times (TAT). KeysightCare offers multiple service agreement tiers, including KeysightCare Assured, Enhanced, and Application Software Support. See the KeysightCare data sheet for details.
KeysightCare Assured	KeysightCare Assured provides a commitment to respond to your engineer's technical needs quickly. When unexpected repairs are necessary, you can count on a committed repair service turnaround time to get you back up and running.
KeysightCare Enhanced	KeysightCare Enhanced includes all the benefits of KeysightCare Assured plus Keysight's accurate and reliable Calibration Services, accelerated and committed TAT, and technical response.
Keysight Support Portal & Knowledge Center	All KeysightCare tiers include access to the Keysight Support Portal, where you can manage support and service resources related to your assets, such as service requests and status, or browse the Knowledge Center.
Education Services	Build confidence and gain new skills to make accurate measurements, with flexible Education Services developed by Keysight experts. Including Start-up Assistance.
Alternative acquisition options	
KeysightAccess	Reduce budget challenges with a lease-based subscription service that offers low monthly payments, enabling you to get the instruments, software, and technical support you want for your test needs.

Recommended services

Maximize your instrument uptime and confidently make accurate measurements by securing technical support, repair, and calibration services with committed response and turnaround times. High-performance instruments include 1 year of KeysightCare Assured or KeysightCare Warranty Plus. Obtain multi-year KeysightCare upfront to eliminate the need for lengthy and tedious paperwork and yearly requests for maintenance budget. Plus, you benefit from secured service for 2, 3, or 5 years.

Service	Function
KeysightCare Enhanced*	**Includes tech support, warranty and calibration**
R-55B-001-1	KeysightCare Enhanced – Upgrade 1 year
R-55B-001-2	KeysightCare Enhanced – Extend to 2 years
R-55B-001-3	KeysightCare Enhanced – Extend to 3 years (Recommended)
R-55B-001-5	KeysightCare Enhanced – Extend to 5 years (Recommended)
KeysightCare Assured*	**Includes tech support and warranty**
R-55A-001-2	KeysightCare Assured – Extend to 2 years
R-55A-001-3	KeysightCare Assured – Extend to 3 years
R-55A-001-5	KeysightCare Assured – Extend to 5 years
Start-Up Assistance	
PS-S40-01	Included – instrument fundamentals and operations starter
PS-S40-04	Recommended – instrument fundamentals and operations starter
PS-S40-02	Optional, technology & measurement science standard learning

* Limited availability might apply. Please review the service definition tool for model number availability and the datasheet for country availability. Coverage might be limited to KeysightCare Warranty Plus (R-55F-001). If KeysightCare Enhanced is available. R-55B-001-2/3/5 must be ordered with R-55B-001-1.

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.

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