Optical Component Test Solutions

Agilent Technologies
Innovating the HP Way

The bandwidth explosion in telecom and IP networks is no longer front-page news, but it is still going on. Demand for greater bandwidth, as well as rapidly changing network technologies and innovative out-sourcing models, present service providers, contractors and equipment manufacturers with new challenges. To rise to these challenges and generate new value, they need to team up with the right partners.

A message from Ned Barnholt, Agilent President and CEO

Manufacturers of optical components and systems need to be first to develop cutting-edge devices, first to volume in a fast-growing and volatile market, and first to deliver a top quality of service.

For more than 60 years, Agilent Technologies has been helping top communications enterprises to succeed. In other words, we support the people who make communications dreams real.

The Agilent approach is to listen closely to our customers, and to make your challenges our challenges. We understand and respond to your factory-floor needs. Our technologies and skills enable you to capitalize on each new wave of the communications revolution.

The following pages explain just why Agilent is the natural choice when it comes to optical component testing.

High volume throughput. We take it seriously.

A critical assignment

The design of test solutions to be deployed in manufacturing processes is heavily influenced by the need to maximize throughput and yield while reducing costs. Ideally, a solution should reduce time to market, increase productivity, and cut the cost of testing.

Optimize your test strategy for high volume throughput

Because any test sequence – handling, connecting and testing – slows down the production cycle time per product, it is essential to implement an optimum test strategy. Striking the right balance between the needs of quality control and the demand for high production throughput is a critical task that calls for the skills and experience of a partner like Agilent Technologies.

Fast ramp-up and minimized test costs

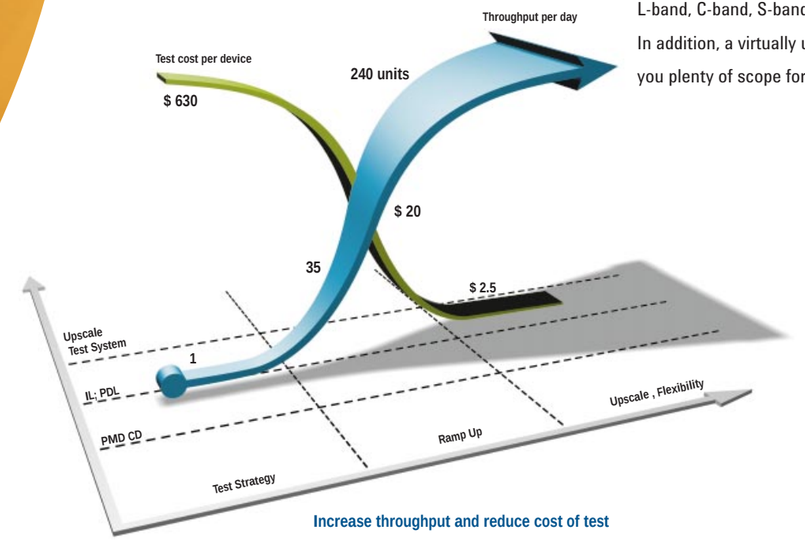
Our solution offering enables you to set up a manufacturing test system quickly and cost-effectively. It comprises a complete portfolio of test instruments, software libraries, and services. The modular approach reduces engineering and programming effort, as well as footprint. Once in place, the test systems are easy to handle and minimize production downtime, resulting in lower cost of ownership. This translates into low unit testing costs, helping you to stay competitive.

Reliable, fast, and highly scalable

Our instruments are designed for use on the factory floor: they are fast, reliable and accurate. Agilent Technologies solutions support parallel testing, delivering high through-puts and yields. And thanks to the flexibility and scalability of the solution platform, you will be able to keep up with the future demands of a rapidly growing market.

Investing in the future

Agilent Technologies' test equipment fulfills the technical specifications needed for the high-bandwidth network. That means it meets tomorrow's requirements today: L-band, C-band, S-band laser and high accuracy for channels with bandwidths of 25 GHz. In addition, a virtually unlimited number of channels can be measured in parallel, giving you plenty of scope for scale-up.



Increase throughput and reduce cost of test

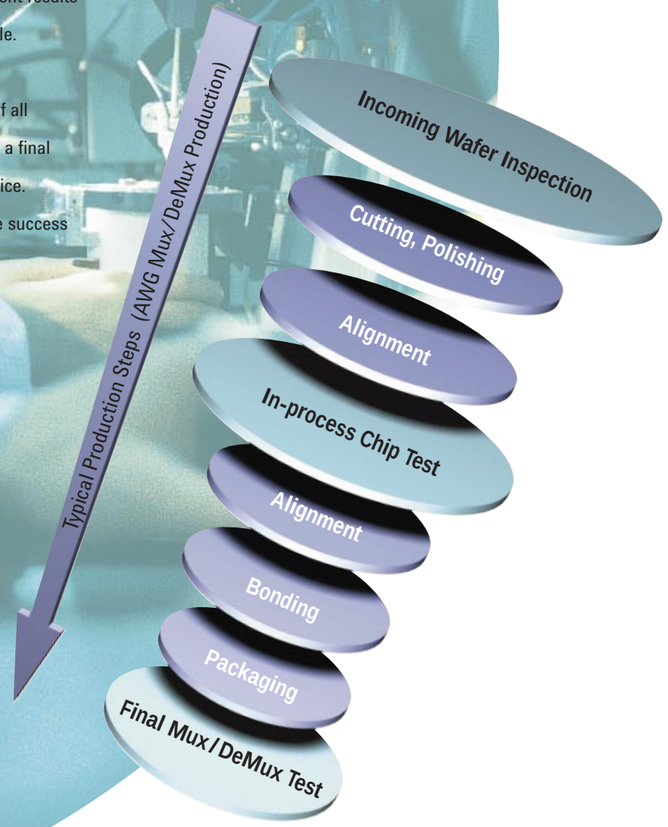
To effectively manage manufacturing quality, you need suitable tools for evaluating actual production processes. In optical component manufacturing, test solutions characterize components according to a comprehensive set of parameters.
The results allow conclusions to be drawn as to the quality of the production process.

Testing for quality at every step

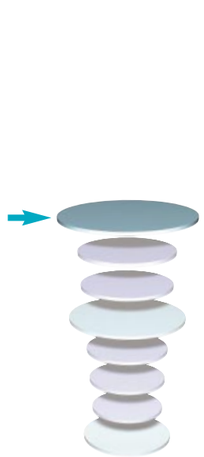
Incoming inspections ensure the quality of optical components or parts that will be used to build optical components. Conducting such inspections at the beginning of the manufacturing process is highly advantageous. At this early stage, delivered parts which fail the test can easily be replaced. This prevents potentially high follow-up costs further down the production line.

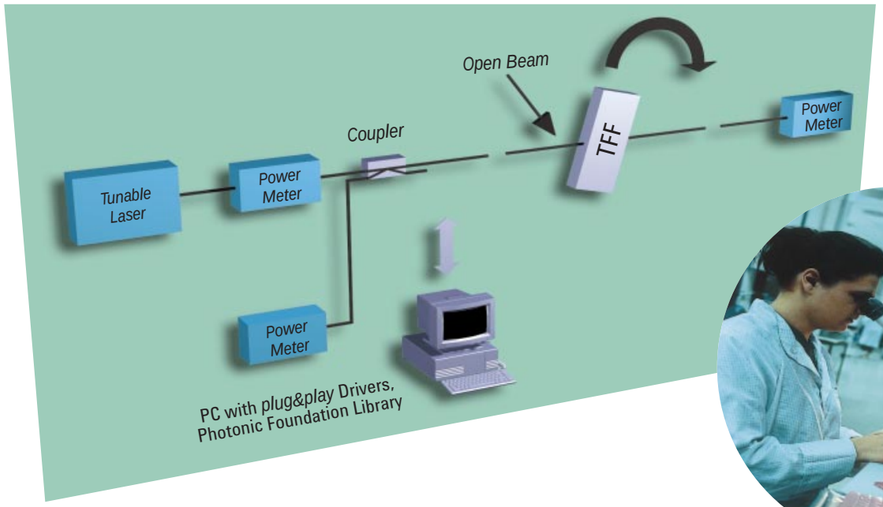
In-process tests examine the optical properties of the component after each key step in the production process. These are usually pass/fail tests. Only if measurement results fall within certain tolerances is further processing of the component worthwhile.

In contrast, **final tests** fully specify the device and entail exact measurement of all component parameters. While tolerance limits are sufficient in pass/fail tests, a final test yields a precise characterization of all the parameters in the produced device.
The test results determine a component's specifications, a key criterion for the success of the product.



Incoming inspection – thin-film filter test





Incoming inspection ensures the quality of sourced optical parts. For example, thin-film filters – used as wavelength-selective elements in optical demultiplexers – must be tested to determine their minimum center wavelength and spectral transfer function.

Challenges:

- Ensure rapid, high-quality measurement of spectral filter properties (Insertion Loss, Return Loss, Polarization Dependent Loss)
- Optimize alignment process and process time: the main drivers of throughput and testing costs
- Minimize test engineering and development effort

The filter is positioned in an open-beam arrangement and aligned perpendicular to the incident optical beam. The tilt position of the filter determines the center wavelength. A common approach for alignment is to minimize the center wavelength of the filter. This requires a fast update of the filter transmission curve over wavelength while tuning the filter position to the incident beam.

The Agilent 81680A, 81640A and 81480A tunable laser sources generate low source spontaneous emission optical output. This is ideal for testing optical filters with high dynamic ranges. An internal real-time wavelength meter ensures maximum wavelength accuracy during a wavelength scan. The Agilent power sensors or optical heads provide low polarization and spectral dependence, minimizing measurement influences. Test solutions can easily be implemented and remote-controlled by means of high-level *plug&play* drivers. The Agilent Photonic Foundation Library contains a large set of ready-to-use measurement and analysis functions.

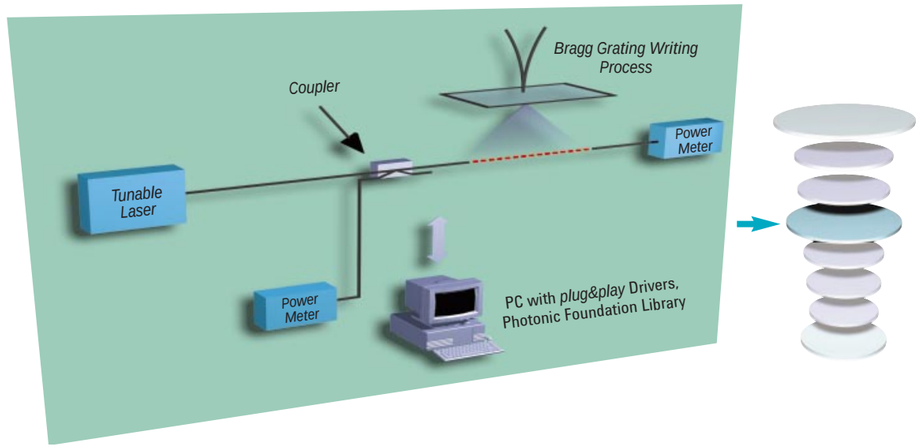
With this configuration, the spectral transmission of the filter is determined with a high degree of accuracy. Automation of the entire alignment and measurement procedure accelerates the inspection process. As a result, the test throughput increases, which directly reduces test cost. The use of *plug&play* drivers and the Agilent Photonic Foundation Library simplifies test engineering, which includes the design and implementation of a test solution.

In-process tests determine the optical properties during or after each major production process. Fiber Bragg gratings, for example, must be qualified for their spectral transmission during or after the writing process of the actual grating structure.

Challenges:

- Optimize throughput by means of in-process testing of spectral transfer function
- Measure spectral filter curve with great accuracy
- Minimize development effort for test solution

In-process test – qualifying fiber Bragg grating during writing process



A typical test setup for the writing process of fiber Bragg gratings employs a tunable laser source capable of fast wavelength sweep cycles. To achieve this for the wide dynamic ranges of fiber Bragg gratings, a tunable laser source with low source spontaneous emission output – such as the Agilent 81680A, 81640A or 81480A tunable laser source – is required to obtain the shape of the filter curve across its full dynamic range. Key features of the source include absolute and relative wavelength accuracy as well as high wavelength resolution.

A single-channel power measurement module with high accuracy and large measurement range, such as the Agilent 81634A power sensor, serves as the receiver unit. The *plug&play* drivers facilitate the implementation of complete test solutions. The Photonic Foundation Library provides measurement and analysis functions that cut test development time to a minimum.

In-process testing of filters requires a measurement solution capable of fast updates of the filter spectral transfer function. As the test is incorporated into the production process, no additional test times occur. This has a significant effect on throughput and reduces the testing costs incurred.

A final test provides an all loss parameter characterization of a passive optical component. The results identify the quality of the component, such as a 40-channel demultiplexer, as detailed in its specifications.

Challenges:

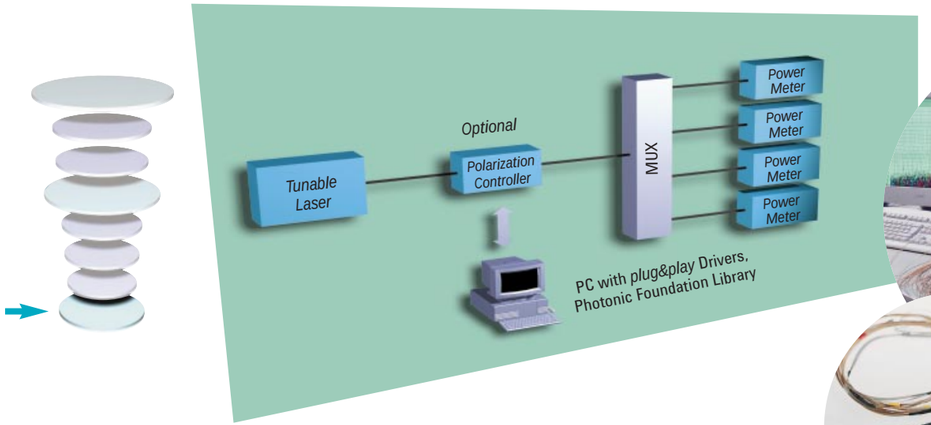
- Fast measurement cycles
- Device specifications based on accuracy of measurement results
- Scalable, flexible test solution
- Reduce development effort for test solution

Typically, a demultiplexer is measured to determine its insertion loss, polarization dependent loss and return loss. Other parameters – such as center wavelength, bandwidth, crosstalk, isolation, passband ripple – can be derived from the insertion loss measurement. Polarization dependent loss is best determined by the Mueller method, which exposes the component to only four well known states of polarization. The PDL measurement is combined with a continuous wavelength scan of the tunable laser sources, which reduces test times significantly. The time to test such a component determines the overall cost of the final test.

As the demultiplexer works as a narrowband filter, wavelength accuracy and resolution are important parameters for the choice of the appropriate test solution. The Agilent tunable laser sources 81680A, 81640A or 81480A provide highest wavelength accuracy in a continuous sweep. To overcome wavelength resolution limitations, a tunable laser source serves as the wavelength selective unit. Due to the dynamic range of demultiplexers, a tunable laser source with low source spontaneous emission is required. The core platforms, 8164A and 8166A, host the power measurement modules as well as the source.

Controlled by the *plug&play* driver, all DeMux channels are measured in parallel. As the number of output channels grows, the test solution can be scaled to the required number of power measurement channels. The modular design of the core platforms allows flexible configuration according to testing needs. It can also be easily extended to include measurement of an even larger set of parameters. Thanks to the *plug&play* drivers, implementing the test solution is straightforward. The Photonic Foundation Library contains a large set of ready-to-use measurement and analysis functions.

Final test – multi-channel demultiplexer test

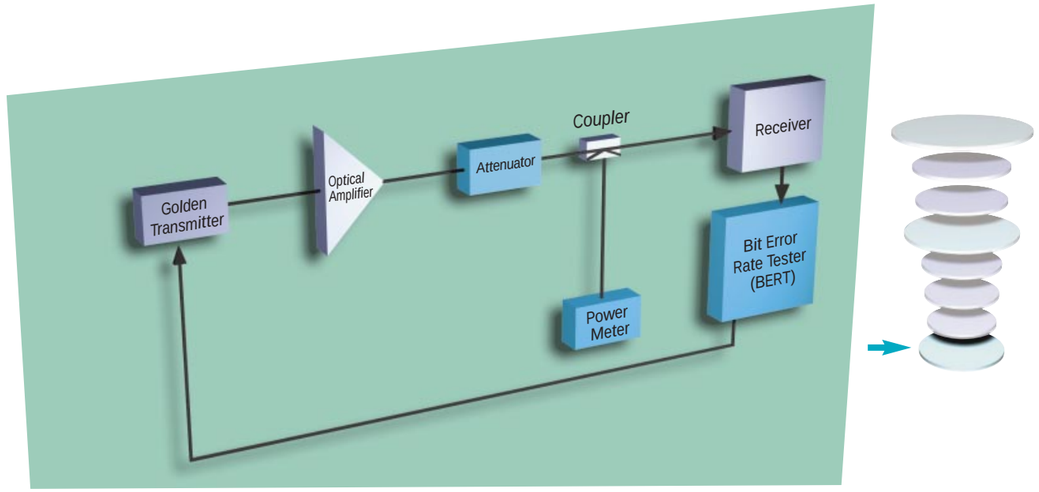


Final test – receiver (Rx) module

The purpose of this test is to specify the performance of the receiver before it is integrated into the line card. The test includes the following characteristics: Bit Error Rate (BER) versus power, eye diagram versus power, BER versus temperature at system OSNR, power and OSNR level for BER threshold and BER at overload.

Challenge:

- Fast, integrated device characterization testing



The figure above shows a typical set-up for optical receiver testing. The optical receiver is one of the devices with a direct impact on the quality of a transmission system and therefore on the quality of service your customers deliver. You want to offer them the best possible performance. We provide the tools you need to deliver that performance.

Agilent Technologies offers a complete family of bit error rate testers, optical attenuators and optical power meters – in fact, everything you need to analyze the performance of your receivers, transmitters and line cards.

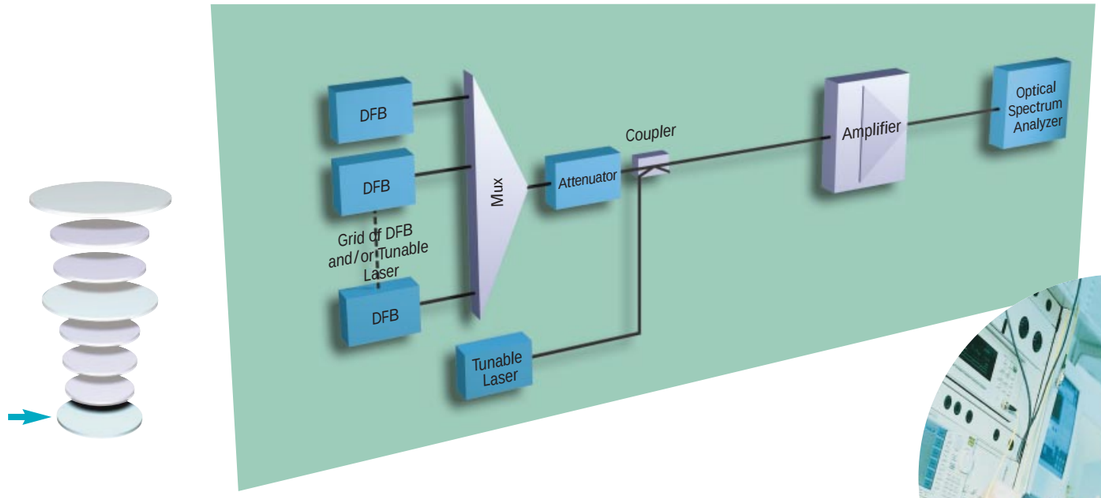
Erbium-doped fiber amplifiers (EDFA) are at the very heart of the revolution in the telecommunication industry. They are the basic building blocks of any long-haul fiberoptic transmission line. EDFA performance is increasingly critical to the success of fiberoptic communication systems.

Amplifier characterization for dense wavelength division multiplexing (DWDM):

Challenges:

- Measure signal power and noise at any channel of a multi-channel signal environment
- Measure gain, noise figure, power and amplified spontaneous emission

Final test – Erbium-doped fiber amplifiers (EDFA)



An amplifier is best tested under realistic operating conditions. Direct and indirect approaches can be used to correctly saturate an EDFA. Direct approaches utilize a source at each channel, with signal power and wavelength corresponding to the DWDM environment. Indirect methods use fewer laser sources and a sweeping small-signal probe to simplify the test apparatus. The above figure shows a generic test set-up.

While measuring gain is easy, it is more difficult to measure the noise contribution at an individual channel. Depending on the measurement method used (time-domain extinction or TDE, interpolation with source subtraction, or signal substitution), devices such as modulators need to be added. A modular test set-up concept simplifies the system and allows a variety of test methods to be employed.

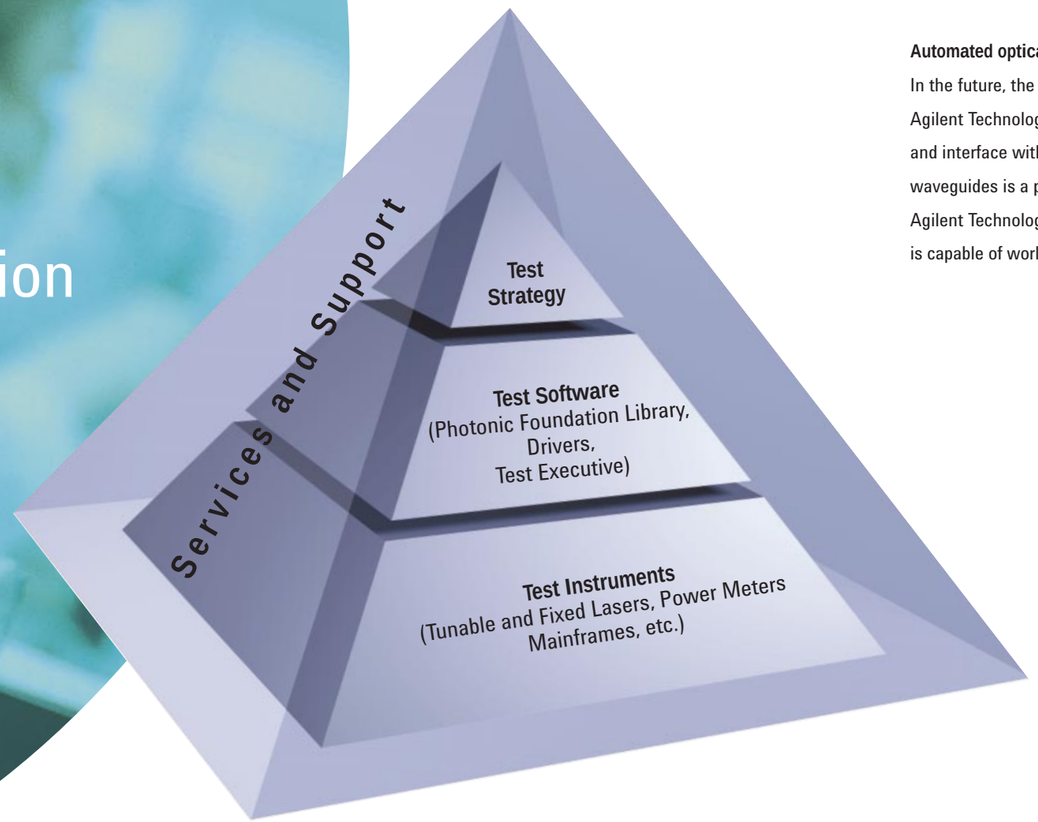
Agilent Technologies offers a complete portfolio of compact tunable lasers and DFB lasers as well as attenuators and optical spectrum analyzers that support all of the above measurement methods.
In addition, Agilent provides ready-to-go solutions for testing EDFAs, customized to your needs.

Automating test and measurement tasks in today's manufacturing environments poses considerable challenges. Both the testing equipment and the software used to control it must integrate seamlessly with manufacturing control systems. Agilent Technologies' lightwave measurement range has been extended to take account of these requirements.

An end-to-end solution

The Agilent solution comprises the following building blocks

- Consulting services to develop an optimum manufacturing test strategy. Taking advantage of Agilent's skills and experience gives you a competitive edge.
- Software building blocks that decrease time to volume and reduce testing costs: The Photonic Foundation Library, and *plug&play* drivers make it easy to implement tests.
- A modular family of optical component test instruments, designed for high throughput: reliable, scalable, and fast, easy to integrate into your manufacturing environment, described in the applications outlined in the previous section.
- Implementation and system uptime services and support – delivered worldwide.



Extending the possibilities

Agilent Technologies doesn't just provide you with testing equipment – every solution is designed for optimum usability. So you reap maximum benefit from your investment. And deploy tomorrow's technology today.

Powerful and convenient function library

Agilent's Photonic Foundation Library (PFL) makes implementing complex measurement tasks easier than ever. The library contains the most frequently used measurement and analysis functions, and includes a rich collection of sample code that can be used immediately. The functions are based on our best designers' profound knowledge of our test instruments, and exploit the capabilities of those instruments to the full. The library is open to integration with a wide variety of hardware and software and combines the advantages of a measurement and analysis toolkit with the convenience of packaged software.

VISA VXI *plug&play* Drivers

Test engineers no longer have to study instrument-specific SCPI commands. Agilent Technologies' *plug&play* drivers allow them to call any instrument function via an easy-to-handle function call, or even through the intuitive graphical user interface of their preferred instrument control language, such as Agilent VEE, LabView, VisualBasic or VisualC++.

Automated optical connection of test devices

In the future, the task of connecting the device to the test station will also be automated. Agilent Technologies' optical component test solutions are ready to connect to, and interface with, robotic workcell solutions. For example, aligning bare fiber ends to waveguides is a prerequisite to measuring those waveguides at the assembly stage. Agilent Technologies has already demonstrated that our lightwave measurement system is capable of working within a fully automated fiber alignment and measurement solution.

Product Portfolio

Tunable Laser Sources

- Precise and fast characterization of critical DWDM components
- Built in wavelength control loop, low noise output
- Available from 1370nm up to 1640nm
- Compact tunable lasers for flexible high channel count solutions

DFB and Fabry-Perot Laser Sources

- Address DWDM system and amplifier testing
- Facilitate high channel-count solutions
- Available from 1530nm to 1610nm (C+L band)
- Output power up to 13 dBm

Power Meters and Optical Heads

- Excellent wavelength accuracy and low polarization dependence
- High dynamic range
- Automatic compensation for source-power fluctuations

Attenuators and Polarization Controllers

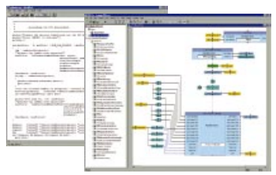
- Ideal for measurements of fast telecommunication systems
- Suitable for single mode
- Built-in monitor paths for overall accuracy

Mainframes

- Variety of plug-in tunable laser and receiver modules for optimized setups
- Faster and more accurate stimulus/response solutions
- Programmable multi-channel sources/easy integration into test applications via *plug&play* drivers over GPIB
- Scalable, small footprint

Software Solutions for High-Volume Manufacturing

- Software library for measurement and analysis functions
- Instrument-specific VISA VXI *plug&play* drivers
- Implementation service for custom solutions



Photonic Foundation Library
- Comprehensive collection of the most frequently required measurement and analysis functions for optical components, packed into building blocks
- Built-in expert knowledge improves over off-the shelf measurement accuracy
- Wide range of supported programming environments

***plug&play* Drivers**
- No need to learn instrument specific commands
- Convenient calling and execution of low-level functions
- Easy upgrading for instrument revisions

Related products: BERTs, Optical Spectrum Analyzers and Wavelength Domain Component Analyzer

- Error analysis technology provides insight into your designs
- Characterize components and systems with built-in test applications
- Fast and accurate measurements of narrowband passive optical filters

Service and support – in partnership with the leader

Worldwide calibration and repair services

Round-the-clock shifts make heavy demands on production and testing systems. Agilent Technologies operates a global service and support organization with our own local service centers. Our offering ranges from classical "return-to-Agilent" calibration and repair services to on-site calibration and maintenance, online technical support, and system uptime services – enabling you to keep test stations up and running within specifications.

Wherever your manufacturing site is, an Agilent Service Center is near: Rockaway/USA, Hachioji/Japan, Winnersh/UK, Boeblingen/Germany, Les Ulis/France, Bangalore/India, Blackburn/Australia, Beijing/China. We are currently establishing new lightwave service capabilities in Seoul/Korea and Chung-Li/Taiwan.

Outsourcing

Leveraging our skills and experience can free you up for more important tasks. Whether you need to develop new, custom test solutions or merely duplicate existing test stations, Agilent is ready to help.

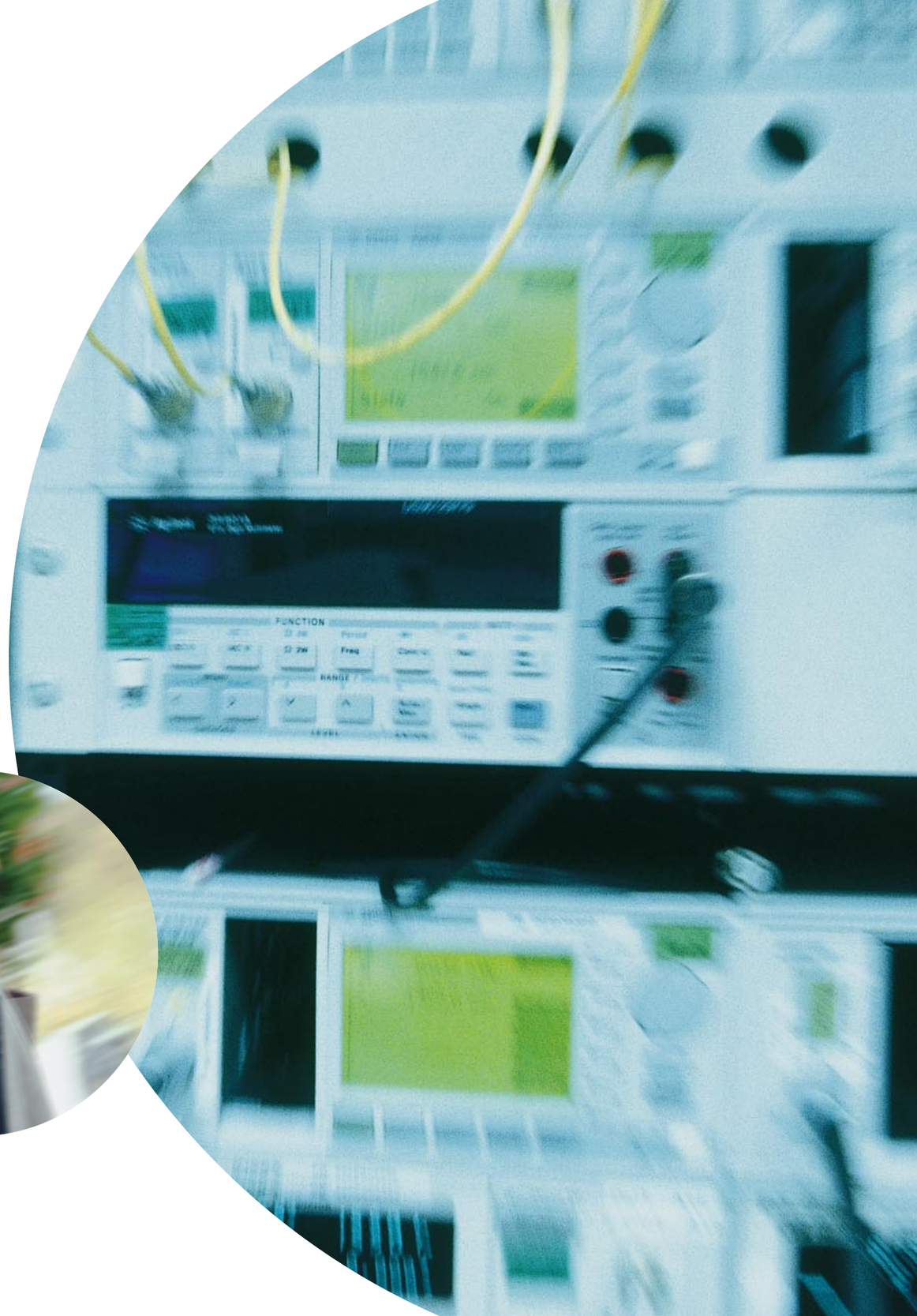
You choose the degree of outsourcing that's right for your organization:

- Take advantage of our expertise, hardware, software, and services
- Order turnkey solutions (Passive Component Test, EDFA Test)
- Team up with Agilent Technologies to develop a custom solution.

Training and consulting services

Agilent offers product, application and technology training either in a classroom environment or on-site at your location. Our consulting services help you develop the right testing strategy and optimize applications. We also pass on our expertise by publishing application notes for our customers´ use.

For further information, please contact your local sales representative.



For more information about Agilent Technologies test and measurement products, applications, services, and for a current sales office listing, visit our web site.

www.agilent.com / comms / lightwave

You can also contact one of the following centers and ask for a test and measurement sales representative.

United States:
Agilent Technologies
Test and Measurement Call Center
P.O. Box 4026
Englewood, CO 80155-4026
(tel) 1 800 452 4844

Canada:
Agilent Technologies Canada Inc.
5150 Spectrum Way
Mississauga, Ontario
L4W 5G1
(tel) 1 877 894 4414

Europe:
Agilent Technologies
Test & Measurement
European Marketing Organisation
P.O. Box 999
1180 AZ Amstelveen
The Netherlands
(tel) (31 20) 547 2323

Japan:
Agilent Technologies Japan Ltd.
Measurement Assistance Center
9-1, Takakura-Cho, Hachioji-Shi,
Tokyo 192-8510, Japan
(tel) (81) 426 56 7832

Latin America:
Agilent Technologies
Latin American Region Headquarters
5200 Blue Lagoon Drive, Suite #950
Miami, Florida 33126
U.S.A.
(tel) (305) 267 4245

Australia/New Zealand:
Agilent Technologies Australia Pty Ltd
347 Burwood Highway
Forest Hill, Victoria 3131
(tel) 1-800 629 485 (Australia)
(fax) (61 3) 9272 0749
(tel) 0 800 738 378 (New Zealand)
(fax) (64 4) 802 6881

Asia Pacific:
Agilent Technologies
24/F, Cityplaza One, 1111 King's Road,
Taikoo Shing, Hong Kong
(tel) (852) 3197 7777

Printed in Germany, February 2001

P/N 5988-1930EN

Agilent Technologies
Innovating the HP Way