JS-1000 Performance Jitter Solution

- Compliance to SONET/SDH standards for clock jitter generation, tolerance, and transfer
- Maximum design insight beyond compliance
- Maximum ROA

O V E R V I E W

The JS-1000 is a high-performance, characterization/verification solution for testing electrical components or modules in optical transport communication systems with the utmost accuracy and repeatability. The solution is a tailored Phase Noise System that measures clock jitter characteristics in the 2.5G and 10G frequency ranges.

JS-1000 was created for designers who want to differentiate their products on performance, time to market, or price, since the Performance Jitter Solution impacts all three. It allows you to characterize your products to SONET/SDH standards for Clock Jitter Generation, Tolerance, and Transfer.

The JS-1000 goes beyond compliance testing to ITU-T 0.172 to offer ongoing competitive advantage in two areas:

1. Maximum design insight through:
   - Lowest intrinsic jitter ("noise floor") of any solution in the industry
   - Repeatable jitter generation measurements (±0.2dB)
   - "Deterministic" jitter output for advanced diagnosis
   - Intentional jitter modulation capability

2. Maximum ROA through:
   - Flexibility to test more than SONET/SDH frequencies: 2.4 - 3.125 Gb and 9 - 13 Gb
   - Flexibility in products tested
   - Re-use of hardware
The JS-1000 derives much of its accuracy and advanced diagnostic capability from using the E5500 Series Phase Noise Solution as a major component of the system, which allows you to examine clock jitter in the frequency domain as well as the time domain.

Measuring jitter in the frequency domain gives you many advantages. For example, frequency domain rms noise measurements have very low intrinsic jitter (<50µUI rms residual jitter @ 10Gb); whereas, time domain-based jitter measurements using oscilloscopes and zero crossings are limited by internal clock sources. You get flexibility in the frequencies you measure beyond Sonet/SDH data rates; diagnostic insight by viewing random and “non-random” components of the jitter; and the capability to measure every zero-crossing on the incoming signal within 100 MHz of bandwidth. In contrast, time domain sampling techniques require a large sample count for statistically valid measurements.

Jitter is just phase modulation. Jitter is the variation in timing of a waveform with respect to a jitter-free reference. Jitter in time domain is proportional to phase modulation in frequency domain. For example, let’s look at an ideal clock signal (red trace) in Figure 1 below.

If you apply phase modulation to the ideal you will get the dashed trace. When the applied phase modulation is positive, the dashed line leaves the ideal. When the applied phase modulation is negative the dashed line lags the ideal. These phase deviations of the zero crossing is also time jitter. If you can measure the phase deviation (in radians), then you can relate that to time jitter. This graph effectively demonstrates that relationship.

The JS-1000 measures jitter in rms radians, so you get unit intervals in rms. For peak-to-peak specifications, you want the peak deviation of that phase shift in terms of radians. The JS-1000 does that as well, but with different techniques.

In summary, jitter is phase modulation. Phase deviation in radians can be converted directly to jitter in unit intervals or time jitter in seconds. Since phase deviation scales directly with carrier frequency, time jitter is unchanged if a clock signal is noiselessly multiplied or divided.
Compliant Measurements: Jitter Generation, Transfer, and Tolerance

Using the JS-1000 Performance Jitter Solution, you get compliant characterization of devices within 2.4-3.1 Gb and 9-13 Gb rates.

Jitter Generation Measurements
- Measure “additive” rms jitter of devices (independent of system clock jitter),
- Have low system intrinsic rms jitter of <50µUI with ±0.2 dB repeatability,
- Measure peak-to-peak jitter independently.

Jitter Transfer Measurements
- Measure jitter transfer characteristics with excellent accuracy and resolution,
- Have 0.005 dB resolution, ±0.01 dB accuracy to 10MHz modulation bandwidth,
- ±0.2 dB accuracy of roll-off to -20 dB, ±0.4 dB accuracy of roll-off to -40 dB,
- Use a special measurement technique to measure wide phase deviation jitter.

For example, see the Jitter Transfer Results display below:

Jitter Tolerance Measurements
- Provide 80 MHz bandwidth of intentional jitter to ±0.5 dB accuracy (5%).

For example, see the Jitter Tolerance display below:
To characterize your devices in a robust way, the JS-1000 provides you with accuracy and repeatability beyond SONET/SDH standards giving you ongoing competitive advantage in two critical areas: Design Insight, and Return On Assets.

1. DESIGN INSIGHT

There are four main features in the JS-1000 that lead to design insight: Lowest Intrinsic Jitter, Deterministic Jitter Output, Repeatability, and Intentional Jitter Modulation Capability.

Lowest Intrinsic Jitter

With other jitter testers you can tell if you meet the ITU 0.172 requirements. With the JS-1000 you can tell by how much, or how much margin you have beyond the requirements. And that helps as you design a complete communications channel, because the jitter components can be additive. You could have multiple components that meet the ITU requirements individually in a channel, but the sum total may exceed the requirements.

Components of interest might be serializers, laser drivers/modulators, line drivers, regenerators, CDRs (clock/data recovery devices), or deserializers.

Deterministic Jitter Output

Deterministic jitter output is great for troubleshooting. You get “base-band” raw jitter output, which includes every zero crossing (100 MHz of bandwidth). Furthermore, you can examine the frequency domain spectrum of raw output plotted, differentiating deterministic “sine wave” jitter from “noise” jitter.

For example, look at Figure 4 below, a 10 GHz clock source, rms jitter measurement.

![Figure 4. 10GHz Clock Source RMS Jitter Measurement](image)

**Start (Hz):** 10E+3  
**Stop (Hz):** 80E+6  
**Phase Mod Value:** 14.9E-3 Rad  
**Jitter:** 237 fsec = 2.37E-3 UI
You can view both random and "non-random" (the spur on the right, for example) contributions to the total rms jitter. This frequency display therefore highlights areas for design improvement.

From the rms phase noise spectrum of the clock, the JS-1000 can derive the total rms jitter contribution. The conversion requires the jitter bandwidth of interest to be specified by the user (note the start offset and stop offset frequencies). Once specified, the total rms phase deviation in rms radians can be determined by integrating the area under the phase noise vs. frequency plot. From the rms radians value, rms jitter in unit intervals can be determined by dividing the rms radians by 2π. In this example, the rms jitter of the clock, over a 10kHz to 80 MHz bandwidth, is 2.37µUI.

The real power of this approach is that you’ve got the insight of the components of jitter vs. frequency offset (from the carrier). This assists in determining the root source of the interfering jitter, shown in the red spurs between 2 and 4MHz above. These spurs may be due to the local clocks used within the DUT, and knowing this information will allow you to efficiently resolve the problem. In comparison, you would not be able to resolve the frequency components of the jitter using traditional time-based techniques.

Repeatability

Repeatability of your measurements is key to gaining the design insight you need to differentiate your products in the marketplace. The superior measurement repeatability of Agilent’s JS-1000 is shown in Figure 5 below. Intrinsic jitter at a 10 Gb rate is typically about ± 2%.

Intentional Jitter Modulation Capability

Compliance specifications require intentional sinusoidal jitter to be applied to the system clock for jitter transfer and jitter tolerance tests. The table below indicates the level of intentional jitter required (columns 1 and 2) and the maximum capability of this system (columns 1 and 3). Having more intentional jitter available—beyond compliance requirements—allows you to stress your components more to find out what operation margin the component actually has.

<table>
<thead>
<tr>
<th>Modulation Rate</th>
<th>ITU-T 0.172 Requirements</th>
<th>JS-1000 Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-80 MHz</td>
<td>0.2 UI pp</td>
<td>0.500 UI pp</td>
</tr>
<tr>
<td>4 MHz</td>
<td>0.2 UI pp</td>
<td>0.625 UI pp</td>
</tr>
<tr>
<td>400 kHz</td>
<td>2.0 UI pp</td>
<td>6.250 UI pp</td>
</tr>
<tr>
<td>10 kHz</td>
<td>2.0 UI pp</td>
<td>500 UI pp</td>
</tr>
<tr>
<td>10 Hz</td>
<td>3,200 UI pp</td>
<td>500,000 UI pp</td>
</tr>
</tbody>
</table>
2. RETURN ON ASSETS

The JS-1000 delivers a low cost of ownership in three ways: frequency flexibility, measurement flexibility, and system elements for re-use.

Frequency Flexibility

The JS-1000 measures the intrinsic jitter of virtually any clock frequency. The current solution measures not just SONET/SDH frequencies, but you have the capability of 2.4–3.125 Gb and 9–13 Gb within one system. This re-use lowers the overall cost of test by spanning these different families of products as well as lowering the cost of future upgrades.

Measurement Flexibility

The JS-1000 measures the optical transport system’s electrical components and modules such as Phase Locked Loops, VCOs, Amplifiers, and Clock/Data Recovery Components. This wide variety of the products tested will save you money on system re-use.

System Elements for Re-use

- Phase Noise Solution
- Microwave spectrum analyzer
- Microwave Source
- Modulation Generator
- FFT 10 MHz Baseband Analyzer
- 100 MHz Bandwidth Oscilloscope

Ordering Information

E5510A  JS-1000 Performance Jitter Solution
Option 412  E8251A Microwave Source
Option 501  71612C BERT + Option UHF

Note: Agilent 71612 BERT "required" but not included.
Worldwide Support & Services

The JS-1000 comes standard with Productivity Assistance for installation, start-up, and training. Through our Call Center Support you can call us with any questions related to the instruments that make up your solution.

With our Cooperative Assistance Agilent works with you to resolve issues jointly regarding system operation and functionality. We have found innovative ways to use the Internet to deliver support to remote locations. Imagine being able to communicate with some of the world’s leading authorities on your measurements.

Agilent offers worldwide support and maintenance with a one-year warranty period on all systems.

Call Agilent Today

If you want the most advanced jitter characterization to aid in differentiating your products, call for a consultation on your particular solution. If you want the best return on assets with your jitter test investments, the new JS-1000 is the right solution for you.

Agilent Technologies Warranty

Agilent hardware products are warranted against defects in materials and workmanship for a period of one year from date of shipment. Some newly manufactured Agilent products may contain manufactured parts, which are equivalent to new in performance. If you send us a notice of such defects during the warranty period, we will either repair or replace hardware products that prove to be defective. Agilent software and firmware products that are designated by Agilent for use with a hardware product are warranted for a period of one year from date of shipment to execute their programming instructions when properly installed. If you send us notice of defects in materials or workmanship during the warranty period, we will repair or replace these products, so long as the defect does not result from buyer supplied hardware or interfacing. The warranty period is controlled by the warranty statement included with the product and begins on the date of shipment.

Agilent Technologies’ Test and Measurement Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty.
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Two concepts underlie Agilent’s overall support policy: “Our Promise” and “Your Advantage.”

Our Promise

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage

Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

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