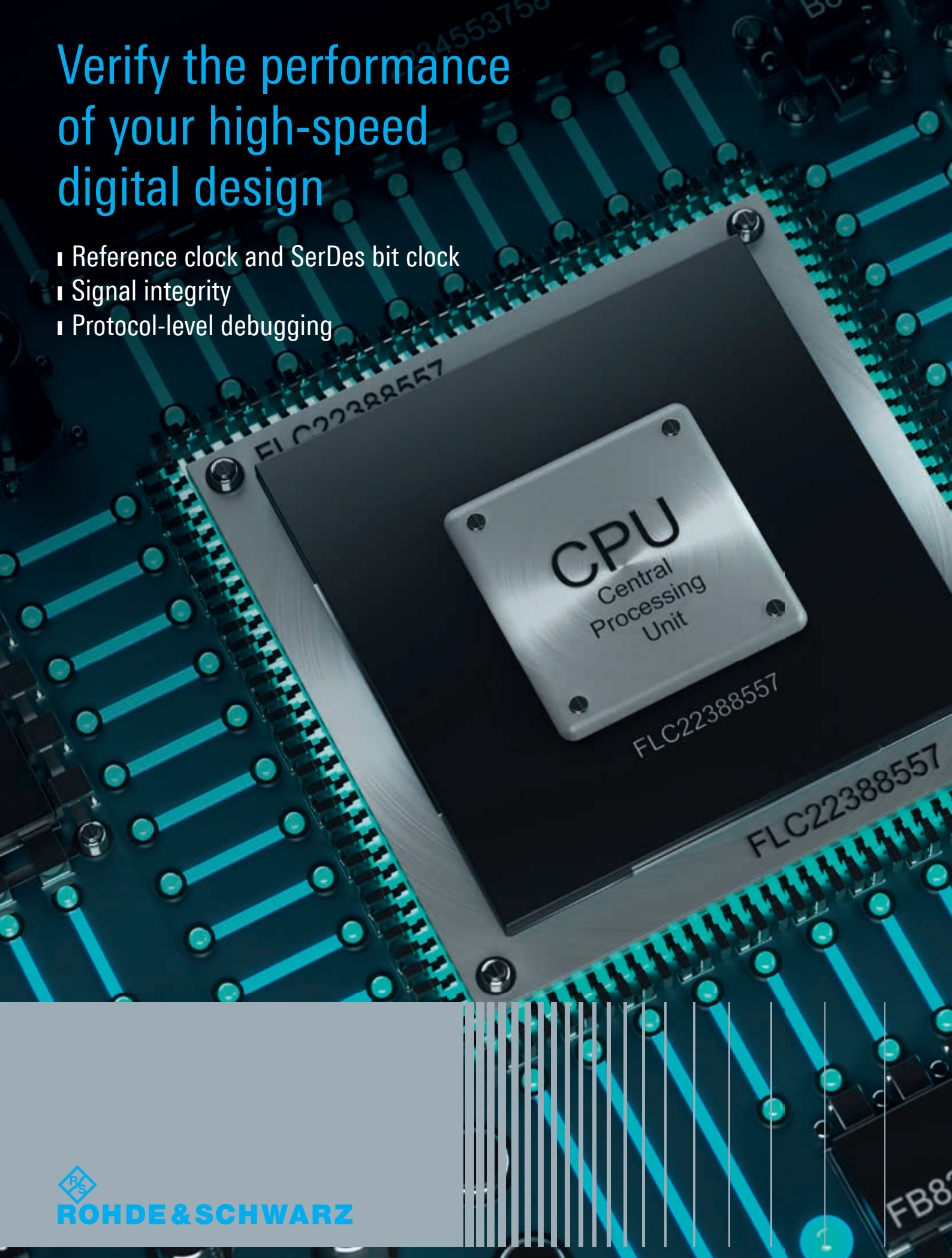
Verify the performance of your high-speed digital design

- Reference clock and SerDes bit clock
- Signal integrity
- Protocol-level debugging



ROHDE&SCHWARZ

Introduction

With over 80 years of experience in the field of test and measurement, Rohde&Schwarz offers a large portfolio of test solutions for electronic and RF design. With more than 70 subsidiaries and representatives around the world, Rohde&Schwarz provides local support and service worldwide.

Our wide range of test instruments and solutions for high-speed digital design include oscilloscopes, spectrum and phase noise analyzers, signal generators, vector network analyzers, power supplies, etc. Rohde&Schwarz products are the result of our technical passion and high-quality engineering in development and production. This passion and strong customer commitment are our inspiration and motivation for industry-leading solutions and expertise in all aspects of electronic and RF design.

Market-leader expertise, cutting-edge instruments and solutions as well as reliable support and service – with Rohde&Schwarz you have a long-term partner at your side to help you tackle the challenges of high-speed digital design:

- Reference clock and SerDes bit clock verification
- Signal integrity analysis and interface compliance testing
- Protocol-level debugging

Related topics:

- Data converter design
  www.rohde-schwarz.com/data-converter

- Signal and power integrity
  www.rohde-schwarz.com/signal-power-integrity

Your challenge…

Modern high-speed digital designs face increasing demands on data rates and compact form factor. This creates new technical challenges on components as well as board-level and system-level designs.

This flyer offers a brief overview of Rohde&Schwarz test and measurement solutions for reference and bit clock verification, signal integrity analysis and protocol-level debugging.

More information is available at:
www.rohde-schwarz.com/high-speed-digital

Clock tree

Reference clock and clock distribution network have a high impact on the overall performance of any high-speed digital design. Spread spectrum clocking (SSC), which adds a low frequency modulation to the clock signal, is often used to reduce unwanted emissions.

Rohde&Schwarz offers:

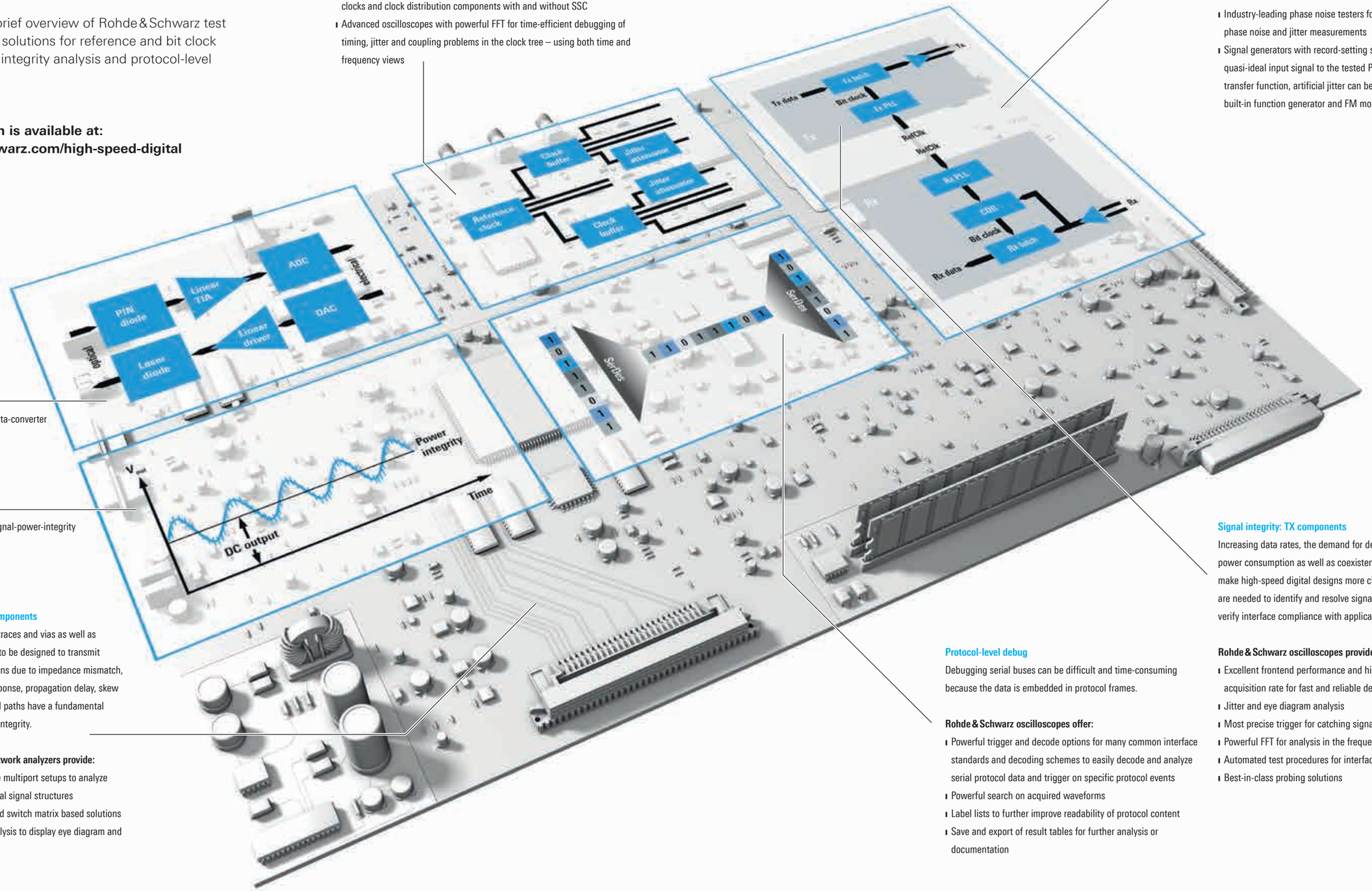
- Industry-leading phase noise testers for verifying ultra-low jitter clocks and clock distribution components with and without SSC
- Advanced oscilloscopes with powerful FFT for time-efficient debugging of timing, jitter and coupling problems in the clock tree – using both time and frequency views

SerDes PLLs

High-speed serial links include low phase noise PLL and CDR circuits to generate a clean SerDes bit clock. The performance of these circuits is typically characterized by their additive phase noise and their jitter transfer function. Growing data rates continuously reduce the phase noise and jitter budgets and cause new challenges in design and verification.

Rohde&Schwarz offers:

- Industry-leading phase noise testers for absolute and additive phase noise and jitter measurements
- Signal generators with record-setting signal purity to provide a quasi-ideal input signal to the tested PLL. To measure the jitter transfer function, artificial jitter can be introduced via the built-in function generator and FM modulator.



Data converter design
www.rohde-schwarz.com/data-converter

Power integrity
www.rohde-schwarz.com/signal-power-integrity

Signal Integrity: passive components

As data rates increase, PCB traces and vias as well as connectors and cables have to be designed to transmit higher frequencies. Reflections due to impedance mismatch, insertion loss, frequency response, propagation delay, skew and crosstalk on these signal paths have a fundamental impact on the overall signal integrity.

Rohde&Schwarz vector network analyzers provide:

- Scalable RF and microwave multiport setups to analyze single-ended and differential signal structures
- True multiport analyzers and switch matrix based solutions
- Advanced time domain analysis to display eye diagram and signal timing

Protocol-level debug

Debugging serial buses can be difficult and time-consuming because the data is embedded in protocol frames.

Rohde&Schwarz oscilloscopes offer:

- Powerful trigger and decode options for many common interface standards and decoding schemes to easily decode and analyze serial protocol data and trigger on specific protocol events
- Powerful search on acquired waveforms
- Label lists to further improve readability of protocol content
- Save and export of result tables for further analysis or documentation

Signal integrity: TX components

Increasing data rates, the demand for dense designs and low power consumption as well as coexistence with wireless signals make high-speed digital designs more challenging. Powerful tools are needed to identify and resolve signal integrity issues and verify interface compliance with applicable standards.

Rohde&Schwarz oscilloscopes provide:

- Excellent frontend performance and high waveform acquisition rate for fast and reliable debugging
- Jitter and eye diagram analysis
- Most precise trigger for catching signal faults
- Powerful FFT for analysis in the frequency domain
- Automated test procedures for interface compliance testing
- Best-in-class probing solutions

Reference and bit clock verification

Clock tree verification

Clock trees are the backbone of all high-speed digital designs and have a major impact on the overall system performance. Modern architectures typically include multiple reference clocks, clock buffers, jitter attenuators, etc. As data rates increase, the specifications for the clock tree and its components get tighter and tighter. Spread spectrum clocking (SSC) is often used in high-speed digital designs, adding further challenges in testing.

The R&S®RTO oscilloscope family from Rohde&Schwarz is the perfect tool for verifying the performance of the clock tree and its components. With its powerful FFT and persistence view, R&S®RTO also helps you efficiently detect and identify coupling effects:

- Excellent frontend performance with low noise and low jitter for optimum signal fidelity
- High waveform acquisition rate for high statistical confidence in measurement results in the shortest possible time
- Powerful and fast FFT to analyze signals in the frequency domain and identify intermittent signals

To stay inside the overall system jitter budget, the jitter specifications for the clock tree and its components are even tighter. For modern high-speed digital technologies, they are already in the sub-picosecond range. Thanks to their superior sensitivity, phase noise analyzers are the instruments of choice for these ultra-low jitter measurements.

The R&S®FSWP phase noise analyzer and VCO tester from Rohde&Schwarz is based on a modern digital demodulator architecture and is the instrument of choice for testing high-quality clocks, clock buffers and jitter attenuators with and without SSC:

- Industry-leading phase noise/jitter sensitivity and test speed
- Absolute and additive phase noise/jitter measurement
- Jitter measurements on SSC clocks

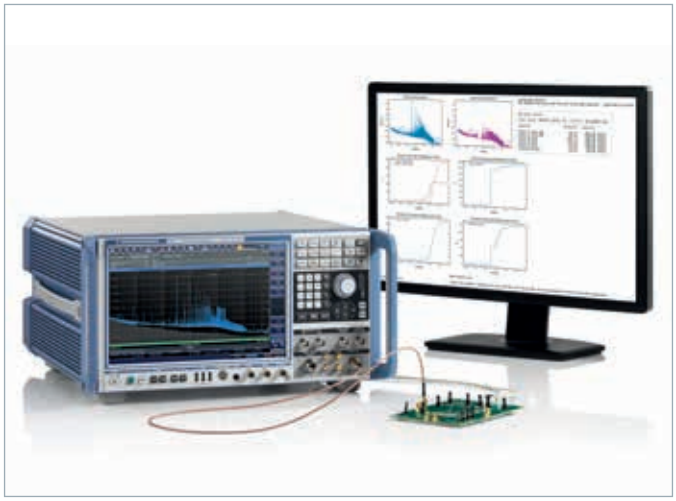
SerDes PLL verification

To convert the reference clock into the SerDes bit clock, low phase noise PLLs are required. Additive phase noise and the jitter transfer function are key performance parameters of these PLLs.

The R&S®SMA100B analog signal generator from Rohde&Schwarz is the ideal tool to stimulate the tested PLL with a quasi-ideal as well as a jittered input signal:

- Industry-leading signal purity to provide a quasi-ideal RF signal
- Built-in function generator and FM modulator to introduce defined artificial jitter on the RF signal
- Optional additional clock synthesizer, providing a differential or single-ended clock signal with selectable waveform and DC offset

Jitter measurement: PCIe SSC Clock



Phase noise measurement

Signal integrity analysis

TX components
Signal integrity has a fundamental impact on the performance of any high-speed digital design and is a primary design goal. Testing is required from early debugging and characterization in R&D to sample validation and final compliance test approval to production and later on service. Transmitter, channel and receiver aspects all need to be addressed. With increasing data rates and higher integration density, signal crosstalk and disturbances from other functional blocks become more and more critical. An example is wireless technologies that are embedded in many applications together with high-speed digital designs, making root cause analysis even more challenging.

Key measurements for signal integrity analysis include jitter measurements such as time interval error (TIE) and total jitter (TJ), eye diagram measurements and eye mask tests, as well as histogram measurements. In combination with the frequency view, even deeper insights into jitter phenomena are possible.

A challenge for signal integrity analysis of serial bus interfaces is the timing reference to the embedded clock signal. Hardware-based clock data recovery (CDR) test solutions provide a significant speed advantage for the result display.

Due to the high integration level of modern high-speed designs, signal integrity, power integrity (PI) and EMI all have to be analyzed. Disturbances from one functional block travel to others via power planes or air. A clean power supply is as important as a clean clock for the performance of the high-speed transmitter and receiver.

Special attention also has to be paid to the appropriate probing solution for debugging signal integrity. Besides the measurement bandwidth, key probe parameters are the capacitive loading, supported voltage ranges and contacting flexibility. Best signal fidelity is often only possible with soldered probe connections.

The R&S®RTO oscilloscope family from Rohde&Schwarz is the ideal tool for signal integrity testing of high-speed digital designs:

- Superior frontend performance with low noise and high measurement dynamic range for optimum signal fidelity
- Up to 1 million waveforms/s acquisition rate for fastest detection of signal anomalies
- Powerful FFT to analyze signals for further insights, including in the frequency domain
- Hardware-based CDR for triggering and fastest acquisition of embedded clock signals
- Fastest eye diagram and histogram analysis
- Most sensitive and powerful trigger system for effective debugging
- Premium probe portfolio with high-performance R&S®RT-ZM modular probe family
- Automated interface compliance test options: R&S®ScopeSuite, incl. test automation and test report

Signal integrity test

Ethernet compliance test

Passive components
Linear distortions in PCB traces and vias as well as connectors and cables need to be within certain limits in order to be compensated by equalization techniques in TX and RX. As data rates increase, these components act more and more like RF and microwave transmission lines and need to be designed and tested accordingly.

R&S®ZNB/ZNBT vector network analyzers from Rohde&Schwarz are the perfect tools to analyze reflections due to impedance mismatch, frequency response, insertion loss, crosstalk and other parameters. Switch matrices can be used to further increase the port count of the network analyzer setup. With the corresponding time domain options, the R&S®ZNB/ZNBT also displays the eye diagram, calculated from the S-parameters of the measured transmission line and provides an eye mask test based on a user-defined eye mask. To show the effects of the overall transmission system, preemphasis, jitter, noise and equalization can also be included in the eye diagram analysis.

Protocol-level debugging

Serial bus interfaces transmit their data embedded in a protocol structure. Especially the higher data rate interfaces like USB and PCI Express utilize a sophisticated protocol structure. This makes debugging of data transfer pretty challenging without dedicated tools.

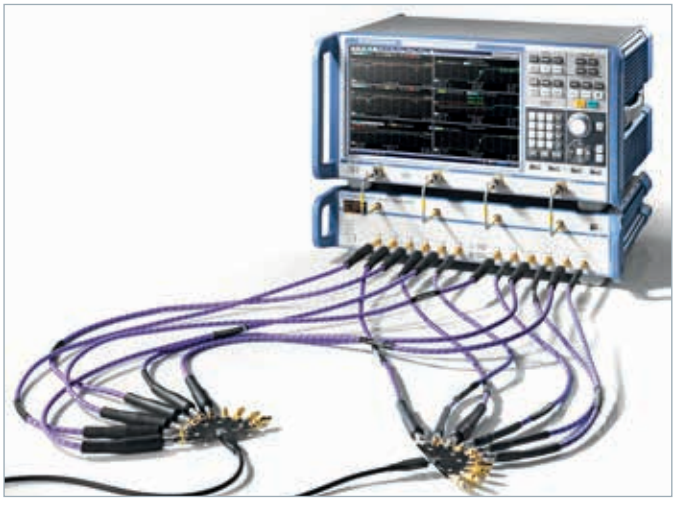
The display of protocol-decoded data, time-aligned to the physical waveform, makes the modern oscilloscope a powerful debugging tool for R&D, but also for service and repair. It allows faults in the data transfer to be correlated with signal integrity issues. Typical serial interface issues include problems with the state machine, where the transmit link cannot be established or the link breaks at the wrong time.

With the oscilloscopes' ability to trigger on protocol events such as start, data content and check sum, debugging can focus on dedicated device events.

The R&S®RTO oscilloscopes feature protocol-base triggering and protocol decoding for most common low-speed and high-speed interfaces. Benefits of the R&S®RTO include:

- Up to four buses can be decoded in parallel
- Protocol details are color-coded
- Reliable triggering on protocol details for efficient debugging
- Comprehensive search capabilities simplify the analysis of long acquisitions

USB-C cable test



Protocol decoding

Service that adds value

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

About Rohde&Schwarz

The Rohde&Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, radiomonitoring and radiolocation. Founded more than 80 years ago, this independent company has an extensive sales and service network and is present in more than 70 countries. The electronics group is among the world market leaders in its established business fields. The company is headquartered in Munich, Germany. It also has regional headquarters in Singapore and Columbia, Maryland, USA, to manage its operations in these regions.

Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

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Verify the performance of your high-speed digital design
Data without tolerance limits is not binding | Subject to change

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