Signal integrity measurements using network analyzers

Users of an R&S®ZNB or R&S®ZNBT network analyzer can now take advantage of a new option: R&S®ZNB/ZNB-K20 makes it possible to display eye diagrams – a time domain analysis function that is commonly used when analyzing signal integrity. By integrating this function into T&M equipment that is at home in the frequency domain, the transmission characteristics of components for analog and digital systems can be determined simultaneously in the frequency and the time domain.

Growing data rates place ever higher demands on the quality of signal transmission paths. There are many factors that influence signal quality, including the effects of cables and connectors. Characterizing all components in a test setup as comprehensively as possible in the time and frequency domains is therefore a vital requirement. The R&S®ZNB and R&S®ZNBT network analyzers with their excellent RF characteristics and high measurement speed are the instruments of choice for this task. The new R&S®ZNB/ZNBT-K20 option makes them even more universal, as it adds the capability to display eye diagrams to the R&S®ZNB/ZNBT-K2 time domain option (Fig. 1). This is done by measuring S-parameters in the frequency domain, transforming the results into the time domain and then applying convolution to the user-defined input bit sequence.

Signal integrity visible at a glance

The repeated superposition of logic level transitions delivers a graphical result known as an eye diagram, a representation typically used in the time domain. Common types of interference such as jitter, noise or transient response distort the evaluation of the logic states, manifesting themselves as a partially or completely closed eye diagram (Fig. 2). The eye diagram immediately shows how influences from the device under test (DUT) and from other components affect the transmission system – a substantial advantage that makes the eye diagram very attractive.

Fig. 1: The new R&S®ZNB/ZNBT-K20 option generates an eye diagram from the S-parameters transformed from the frequency into the time domain.

Fig. 2: Left: transmission system unaffected by interference; right: transmission system with simulated interference.
Simulation of various types of interference
If the transmission quality of a system approaches tolerance limits, interference such as jitter or noise can be virtually added to determine a system’s robustness to these effects, which are to be expected in real life, and determine whether a system satisfies defined performance requirements under these conditions (tolerance analysis). The vivid graphical representation in the form of an eye diagram facilitates analysis.

Improving signal quality through preemphasis and equalization
Systems theory describes various methods that can be used to improve the quality of signal transmission paths when they are subjected to interference. Such methods include preemphasis and equalization. In the case of preemphasis, a potentially undesired change in the signal, caused by the DUT, is counteracted by predistorting the input signal in order to balance out the distortion of the DUT characteristic. Equalization, on the other hand, compensates for the power loss typical of high-frequency signal components by raising the transmission characteristic on the receiver end to a higher level toward higher frequencies. The R&S®ZNB/ZNBT-K20 option can implement these two methods by way of calculation. The effect of these measures is immediately visible from the eye diagram.
Fast pass/fail analysis with configurable mask tests
In addition to classic pass/fail testing to verify compliance with limit values, R&S®ZNB/ZNBT-K20 offers a mask test function that can be used to check whether measured values fall within the permitted range. Mask violations are signaled with a pass/fail indication (Fig. 3).

Standardized interfaces such as USB, HDMI and DVI must comply with the specifications laid down in the standards. The masks are individually configurable, simplifying signal quality analysis in development (Fig. 4).

Easy to operate due to full integration into network analyzer firmware
The R&S®ZNB/ZNBT-K20 menus seamlessly integrate into the intuitive network analyzer GUI. Configuring the eye diagram display takes just a few steps – no need to switch to external software or restart the instrument. All setting functions are easily accessible. Thanks to a clear-cut representation of the signal flow, users always keep track of the settings and can quickly switch relevant parameters on or off (Fig. 5).

Highest accuracy through system error correction and embedding/deembedding function
The eye diagram is a familiar tool especially for oscilloscope users. However, considering today’s high data rates and the associated high transmission frequencies, time domain measurements become increasingly complex and error-prone. Vector network analyzers, which deliver such measurements as standard, offer an interesting alternative. Expanding an R&S®ZNB or R&S®ZNBT network analyzer with the R&S®ZNB/ZNBT-K20 option provides users with the best of both worlds.

Network analyzers offer the following advantages:
- High measurement accuracy due to vector system error correction (compensation for reflections and losses)
- Embedding/deembedding function for adding/removing virtual networks (e.g. test fixtures, adapters) in the frequency and time domain
- Gating function to eliminate the effects of discontinuities (e.g. connectors, adapters)
- Simultaneous frequency and time domain measurements
- Large bandwidths up to 40 GHz with the R&S®ZNB40
- Realtime measurement and continuous update of eye diagrams for adjustment purposes
- High dynamic range

Summary
Network analyzers equipped with the R&S®ZNB/ZNBT-K20 option can display eye diagrams and deliver comprehensive, precise signal integrity measurements. The new software option is fully integrated in the intuitive R&S®ZNB/ZNBT network analyzer GUI, allowing users to configure measurements quickly and conveniently for maximum efficiency in development.

Anja Paula

Fig. 5: Relevant parameters can be switched on or off in the menu representing the signal flow.