The IEEE Technical Committee 10: The Waveform Generation, Measurement, and Analysis Committee

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The IEEE Technical Committee 10 (TC-10), the Waveform Generation, Measurement, and Analysis Committee of the IEEE Instrumentation and Measurement (I&M) Society, seeks to support the advancement of industries and other entities that research, develop, manufacture, and use technologies and instruments that generate or acquire signals. These signals are used in most if not all interfaces between humans and technology, such as, but not limited to, communication, computing, transportation, medicine, entertainment, manufacturing, and agriculture. In fact, it is very difficult to identify a human activity, other than the primitive, that is not in some way touched by electronics. So, in the broadest interpretation of the goal of the TC-10, it could be said that the TC-10 impacts everyone. Because the TC-10 is a developer of documentary standards, the TC-10's goal is achieved by fulfilling, as best as possible, the global need for standardized terms, test methods, and computational methods that are used to describe and measure the parameters that describe the performance of signal generators and waveform recorders and analyzers. The TC-10 has developed and maintains the following documentary standards: IEEE Std 181-2011, Standard on Transitions, Pulses, and Related Waveforms [1]; IEEE Std 1057-2017, Standard for Digitizing Waveform Recorders [2]; IEEE Std 1241-2010, Standard for Terminology and Test Methods for Analog-to-Digital Converters [3]; IEEE Std 658-2011, Standard for Terminology and Test Methods for Digital-to-Analog Converters [4]; the IEEE Std 1696-2013, Standard for Terminology and Test Methods for Circuit Probes [5]; and the IEEE Std 2414-2020, Standard for Jitter and Phase Noise [6]. Additional information on these standards can be found in [7].

The TC-10 comprises over 50 members from around the globe (as exhibited by the time-zone member distribution of Fig. 1), with the majority in Western Europe and the United States. The members are an international group of electronics engineers, mathematicians, professors and physicists with representatives from national metrology laboratories, national science laboratories, component manufacturers, the test instrumentation industry, academia, and end users. Developing standards in the fields of the TC-10 means being at the forefront of the transfer of knowledge from research to manufacturing and vice versa. For academicians, it is an excellent opportunity to interact with industry and learn of their technical

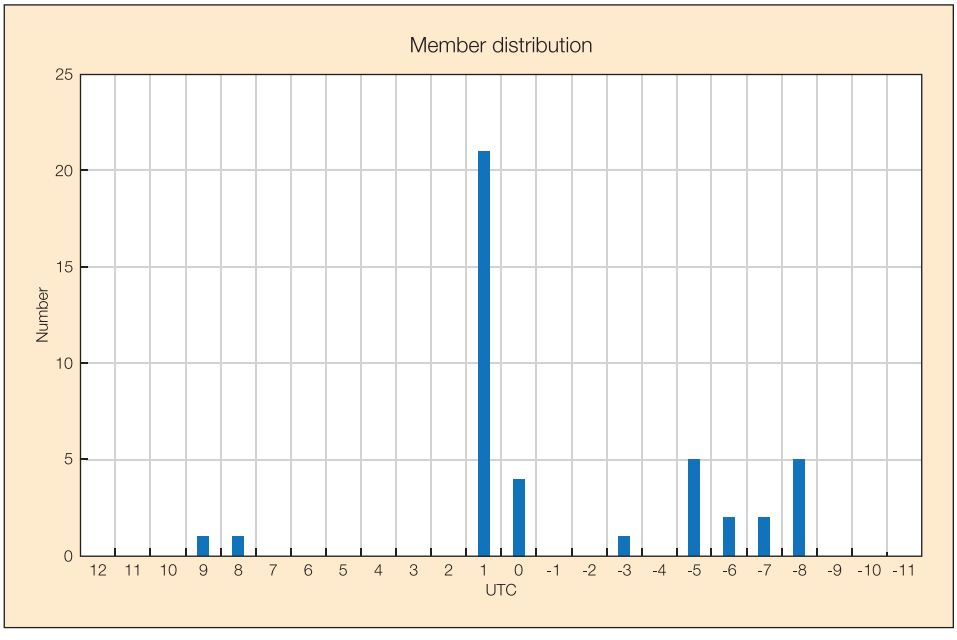

Fig. 1. Member distribution by time zone. UTC is Coordinated Universal Time.

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and practical needs and issues regarding the testing of instrumentation and equipment. For production and research engineers, being a TC-10 member provides an excellent opportunity to develop contacts with university researchers and learn of their applicable research and theories. From the manufacturers' point of view, being part of a standards-development working group provides exposure to the latest research that is applicable to practical production issues. From the users' point of view, TC10 membership provides an open and balanced platform to present their needs to the manufacturers and researchers and to obtain a clarification in terminology, which is the basis of product comparison.

One of the most fundamental documentary standards maintained by the TC-10 is the IEEE Std 181-2011, *Standard on Transitions, Pulses, and Related Waveforms* [1]. This standard describes definitions and measurement methods for waveforms, which are the measured replicas of signals. The description of the performance of any electronics device that generates, transmits, or receives pulse-like signals would be used by this standard. Fig. 2 shows some of the parameters that are used to describe a pulse waveform. The Std 181 defines about 100 terms and provides computational methods for many of them. The IEEE Std 1241-2010, *Standard for Terminology and Test Methods for Analog-to-Digital Converters* [3]

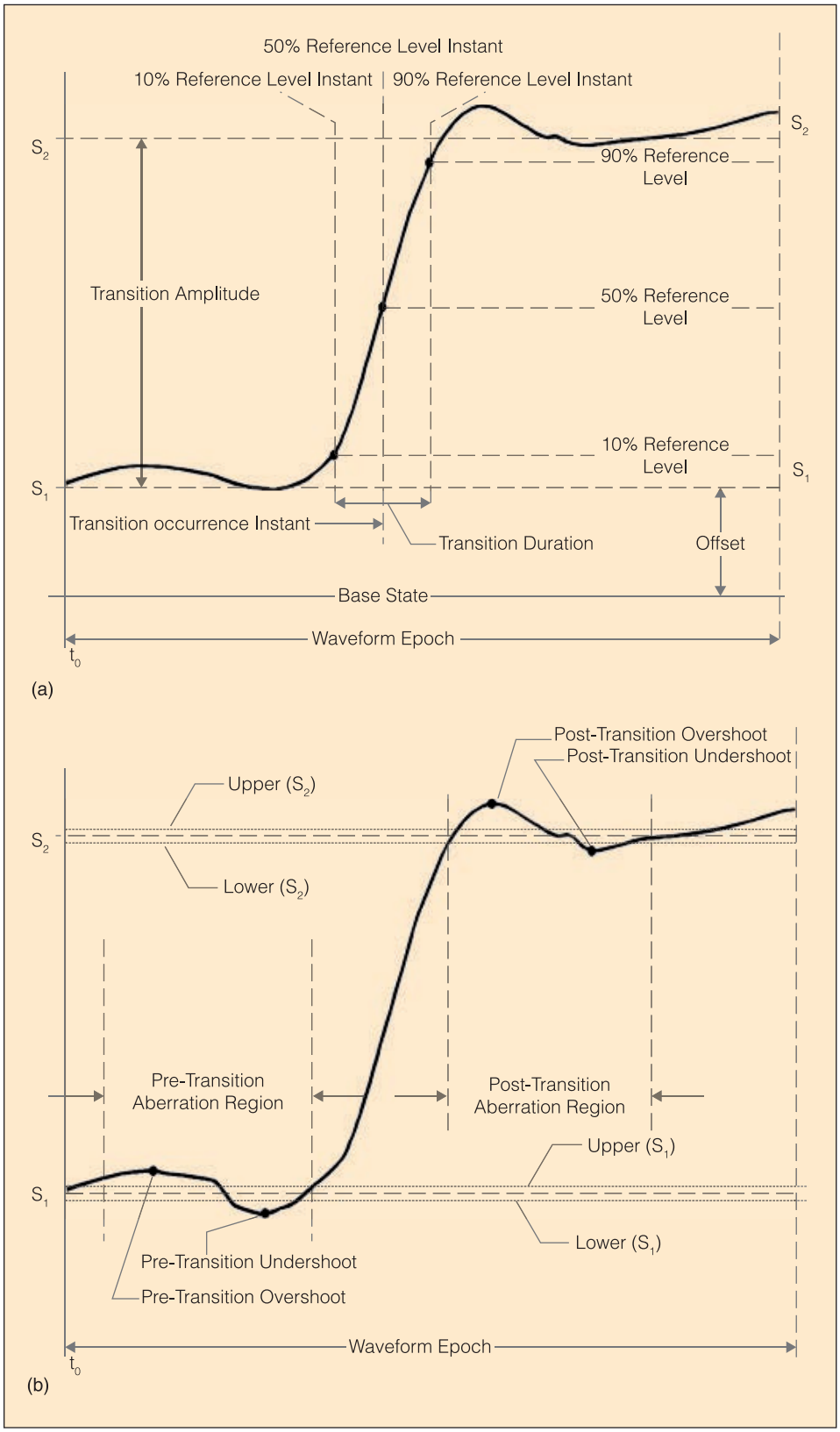

Fig. 2. Two plots displaying various parameters used to describe the characteristics of a waveform. The plot on the left shows the fundamental waveform parameters on which all other parameters are derived. The plot on the right shows the parameters that are used to describe aberrations of a waveform (from [7], ©2020 IEEE).

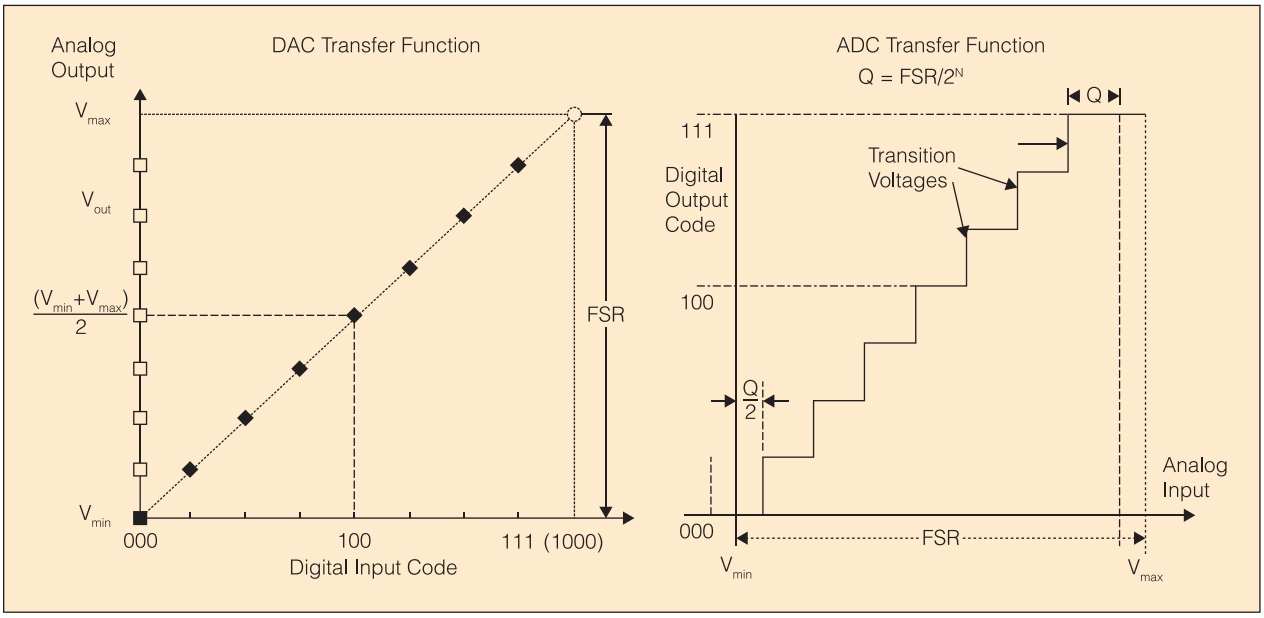

Fig. 3. Transfer functions of ideal 3-bit unipolar DAC and ADC (from [7], ©2020 IEEE).

and IEEE Std 1658-2011, *Standard for Terminology and Test Methods for Digital-to-Analog Converters* [4] are basic documentary performance standards that address the primary functions of analog and digital signal generation and acquisition. These electronic devices provide the means by which information is communicated and shared. Fig. 3 compares the transfer functions of the complementary purposes of the two different converters.

The IEEE Std 1057-2017, *Standard for Digitizing Waveform Recorders* [2]; the IEEE Std 1696-2013, *Standard for Terminology and Test Methods for Circuit Probes* [5]; and the IEEE Std P2414-2020, *Standard for Jitter and Phase Noise* [6] describe complex systems. The Std 1057 is a documentary performance standard for waveform recorders and, because of its reliance on analog-to-digital converters (ADCs), has some similarity in content with the Std 1241. The Std 1057 predates the Std 1241, which was written to address ADC applications other than that for waveform recorders where understanding the performance of the ADC without embedding into other electronics is important. The Std 1696 is a terminology and test methods documentary standard that includes definitions and measurement methods for different types of probes (see Fig. 4, for example). The Std 2414 was published recently, in 2020, and provides definitions and computational methods for different types of jitter. The

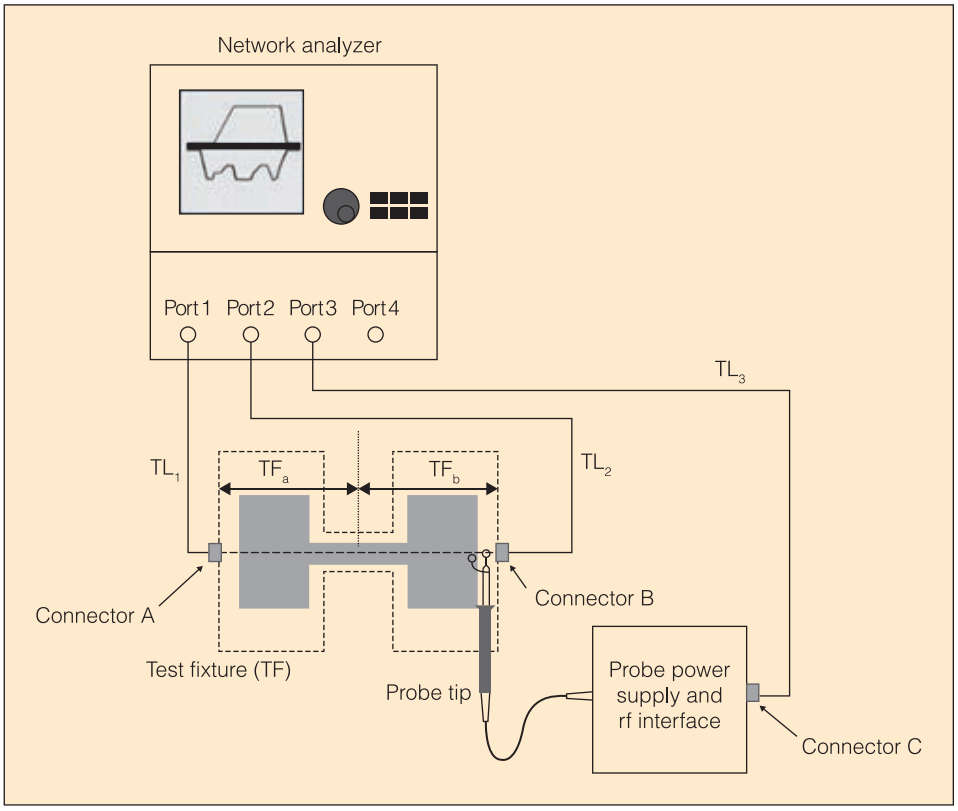

Fig. 4. Test setup for measuring the input impedance of single-ended stand-alone probe (from [7], ©2020 IEEE).

primary purpose of this standard is to harmonize all the different jitter definitions from many other standards development organizations.

The TC-10 is currently engaged in the revision of the Std 181, Std 1241, Std 1658, and Std 1696. The TC-10 invites you to participate in these revisions. These standards are essential for accurate, reproducible, reliable, and communicable characterization of the performance of these devices, which supports technology and product advancement, product comparison and performance tracking, and device calibration and traceability. The IEEE TC-10 continually updates and improves its existing standards and develops new ones as needed by its stakeholders. The TC-10 encourages fresh ideas and new perspectives. If you are interested in the TC-10's work and would like to join one or more of its subcommittees, please visit the TC-10 home page at http://tc10.ieee-ims.org/tc10-home. Contact information for the subcommittee chairs can be found at this home page.

References

[1] *IEEE Standard for Transitions, Pulses, and Related Waveforms*, IEEE Std. 181-2011, Institute of Electrical and Electronics Engineers, 2011.

[2] *IEEE Standard for Digitizing Waveform Recorders*, IEEE Std. 1057-2017, Institute of Electrical and Electronics Engineers, 2017.

[3] *IEEE Standard for Terminology and Test Methods for Analog-to-Digital Converters*, IEEE Std. 1241-2010, Institute of Electrical and Electronics Engineers, 2010.

[4] *IEEE Standard for Terminology and Test Methods of Digital-to-Analog Converter Devices*, IEEE Std. 1658-2011, Institute of Electrical and Electronics Engineers, 2011.

[5] *IEEE Standard for Terminology and Test Methods for Circuit Probes*, IEEE Std. 1696-2013, Institute of Electrical and Electronics Engineers, 2017.

[6] *IEEE Standard for Jitter and Phase Noise*, IEEE Std. 2414-2020, Institute of Electrical and Electronic Engineers, 2017.

[7] S. Rapuano, J. Jendzurski, L. De Vito, S. J. Tilden, W. B. Boyer and N. G. Paulter, "The documentary standards of the IEEE technical committee 10," *IEEE Instrum. Meas. Mag.*, vol. 23, no. 8, pp. 8-13, Nov. 2020.

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William Boyer is retired from Sandia National Laboratories in Albuquerque, New Mexico, USA. For most of his career at Sandia he was responsible for the development of large high speed data acquisition systems. He is currently the chairman of the TC-10 subcommittee responsible for the IEEE 1057 Waveform Recorder standard.

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