

Adding Value to Arbitrary Generators

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Abstract: Producing diverse waveforms to provide additional signals from a missing or difficult-to-obtain component or sensor historically has been delivered by multiple dedicated signal sources. This required sourcing and maintaining separate, dedicated sources, or even custom-designing or modifying sources for a specific project. With the arrival of digital sampling technology and digital serial processing techniques, just one signal source instrument, the arbitrary generator, can deliver almost any type of signal generation required. The new arbitrary generators enable electronic design engineers to meet the needs of analog and embedded processor applications with versatile signal sources that provide high signal frequencies, high-fidelity signal replication and stable clocks.

I. Introduction

During the design and production of electronic products, complex circuitry or subsystems need to be tested and often require additional signals from a missing or difficult-to-obtain component or sensor. These signals can be as simple as an audio frequency or clock signal or more complex like a serial data stream or the signal from an airbag sensor during a crash. Signal sources to generate and simulate these signals have been around for many years, but their pace of development has been rapid in recent times.

Historically, the task of producing diverse waveforms has been filled by separate, dedicated signal sources, from ultra-pure audio sine-wave generators to multi-gigahertz RF signal generators. Users have often had to custom-design or modify a signal source for the specific project. The advent of digital sampling technology and digital signal processing techniques has now led to a solution that answers almost any kind of signal-generation need with just one instrument: the arbitrary generator.

II. Filling the Gap

Arbitrary generators can be classified as arbitrary/function generators or arbitrary waveform generators. The arbitrary/function generator delivers classic sine, square or other regular waveforms with a high degree of precision and stability, along with basic arbitrary waveforms and sometimes also pulse generation capability. In comparison, the arbitrary waveform generator can offer a wide range of even complex waveform variations. However, as will be shown below, there is a gap between these two classes of instruments, that currently leaves customers no alternative, but to buy multiple products, no one of which meets their complete needs.

Applications for arbitrary waveform generators are numerous and span a broad range. One benefit of the arbitrary waveform generator is that it can replace a 'real' source that is unavailable during the test. Sometimes, the real signal is acquired using an oscilloscope and downloaded into the generator's memory from where it can be replicated. The arbitrary waveform generator also allows an ideal signal to be augmented with anomalies and impurities that the device under test is expected to encounter in real-world situations. Arbitrary waveform generators are also ideal for generating long sequences of complex and/or high bandwidth signals such as those required to test frequency-agile pulse

compression radars. Users with a need for less complex signals have typically used arbitrary/function generators; however these users commonly express a significant number of frustrations with such equipment.

III. Market Challenges

While not necessarily having a need for high-end arbitrary waveform generators, the users of arbitrary/function generators have some key needs that must be satisfied to enable them to perform their work in design, validation or manufacturing test. A common frustration with existing arbitrary/function generators is that their operation is difficult to learn and easy to forget, causing poor productivity. Ease of use is also valued by schools and universities where students often work with an instrument only once and are expected to learn from the nature of the experiment. This purpose is defeated if it takes too long to learn the operation of the instrument.

Recent industry surveys have identified a number of key customer requirements, which can be summarized as follows:

- must provide exactly the right signal and provide a graphical representation to confirm correct set-up
- easy-to-learn and easy-to-use
- easy to understand current status/setup of machine
- reasonably affordable price based on cost/benefit
- large frequency range
- frequency stability appropriate connector layout
- low failure rate
- Remote interface support of current standards such as USB and/or LAN.

A small footprint is also valued since users often have crowded benches and signal sources are generally used in combination with other test gear such as oscilloscopes, voltmeters, spectrum analyzers and power supplies.

IV. Price/Performance Considerations

Performance requirements are driven by the advent of higher-speed CMOS and DAC devices, so that signal generators have to have higher sampling rates and signal bandwidth, finer frequency setting resolution, flexible modulation capabilities, pulses with shorter rise and fall times, and higher signal purity. For example, most embedded processor applications use frequencies beyond 50 MHz and up to 200 MHz or higher.

Arbitrary/function generators have been available at “value” price points for a number of years, putting them on a par with the portable digital oscilloscopes with which they are often used. However, there are some significant price/performance gaps in the market. There are many arbitrary/function generators covering the frequency range from 10 to 100 MHz and with sampling rates of 100 MS/s to 200 MS/s, but above these ranges users have been forced to use more costly combinations of single-function products such as RF signal generators and pulse generators.

V. Meeting the Challenges

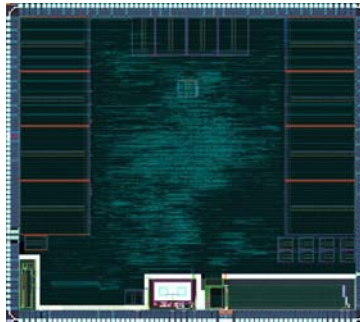
These shortcomings have now been addressed in a new range of instruments that add significant value through unprecedented performance, effectively closing the market.

The new Tektronix AGF3000 Series are designed for engineers who test electronic circuits with one or more signal inputs and various waveshapes at frequencies up to 240 MHz, generate arbitrary

waveforms up to 2 GS/s, need up to 1ppm clock stability, and desire an intuitive, easy to use graphical user interface. Significantly, for applications requiring signals with sampling rates of 1000 MS/s or more, the AFG3000 Series saves users up to 75% of the cost of current alternative high performance gear.



The key to the combination of high performance, compactness and affordable price is a new ASIC known as the GoC (Generator on a Chip), which combines direct digital synthesis circuitry, a 2 GS/s digital/analogue converter, waveform memory, modulation, burst and sweep circuits on a single 0.18 μm CMOS chip



In addition to the high output frequency, fast sample clock and high-speed pulse waveforms, the new instruments offer the ability to have independently adjustable leading and trailing edge speeds for pulse waveforms. This is especially useful for characterization of semiconductors and amplifiers possessing unsymmetrical slew rates.

A graphical user interface based on a large color LCD display makes the instruments easy to use – even for infrequent users. The relevant instrument settings are viewable at a single glance, along with a graphical confirmation of the desired waveshape.

USB connectivity provides convenient instrument control and waveform transfers via a USB memory stick between signal source, PC and oscilloscope, to extend the AFG3000's waveform storage to a virtually unlimited capacity.

Customers in the computer, communications and consumer industries often need two or sometimes more signals to simulate data and clock, analogue and binary control signals, or multiple sensor signals. These users will appreciate having a second channel in the same instrument. Featuring the shortest depth in this instrument category, the new generators even fit on crowded test benches. Additional space savings are realized when two or more signals are needed because of the second channel in the same instrument.

Thanks to the largest display in its class and intuitive user interface, operation of the AFG3000 is easy to learn, enabling engineers to focus on their design tasks and improve time to market rather than spending time learning how to use the instrument. Finally, ArbExpress 2.0 software extends the ease of use to the creation and editing of arbitrary waveforms. ArbExpress seamlessly transfers MatLab files and oscilloscope data, eliminating tedious conversion and modification. It also allows the building of equations with ease, using interpreter-based logic and a wide range of functions.

VI. Meeting Future Needs

These new generators enable electronic design engineers to meet the needs of analogue and embedded processor applications for a versatile signal source to provide high signal frequencies, high-fidelity signal replication and stable clocks. The combination of pulse, function and waveform generation makes them the optimum solution for a wide range of present and future applications.

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