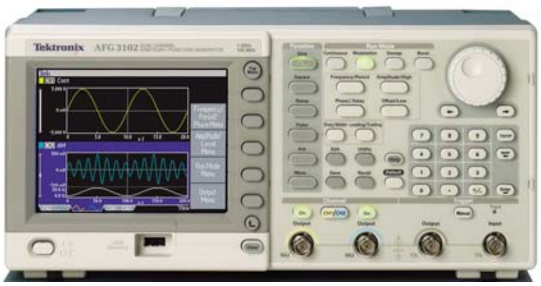
Signal Generators Aid Test and Measurement Challenges - Testing and Validation

AFG3000 Series Arbitrary/Function Generator

AFG3000 Series



The AFG3000 Series arbitrary/function generator is indispensable for testing and validating IC devices and circuits

The signal generator is among the most important tools for the validation of electronic devices such as semiconductors, because a signal input is the essential means for testing new IC and circuit response characteristics. The signal output capabilities of a signal generator are crucial for testing and validating the performance limits of the device under test.

To this end the AFG3000 Series arbitrary/function generator offers excellent performance. It is user-friendly and affordable. Due to features such as separately adjustable pulse rise time and fall time, it is possible to identify any problem during the early stages of a setup and production process, and to minimize the costs for necessary modifications. Furthermore, the AFG3000 Series produces accurate, stable, high-fidelity signals. The informative user interface ensures that results are presented clearly on one screen, easy to understand and to interpret.

Op-amp slew rate validation

The following is an introduction to the characterization of op-amp rising and falling signals. This example uses a 220 MHz high speed op-amp with a video signal line driver. When the rising edge of a video signal reaches a relatively large amplitude at a fast rate, the slew rate becomes critical for circuit characteristics.

The circuit diagram for the slew rate test is shown in Figure 1. The AFG3000 Series arbitrary/function generator feeds a pulse wave into the op-amp inverting input (indicated by “+” in the circuit diagram). An oscilloscope (TDS5000 Series) connected to the op-amp output measures the high to low and low to high transition responses.

When the pulse waveform is selected, the display shows all the important parameters such as signal frequency, amplitude, pulse duty cycle and edge rise and fall times. Furthermore, it is possible to select the waveform parameters (Figure 2).

During the validation of the op-amp slew rate performance characteristics, while the rise time and fall time of the input pulse are slightly modified, the op-amp output signal waveforms are displayed on the oscilloscope screen. With the AFG3000 Series, it is possible to control the rising and falling edge separately. In Figures 3 through 5, the op-amp input signal is shown in yellow and the output trace is shown in blue.

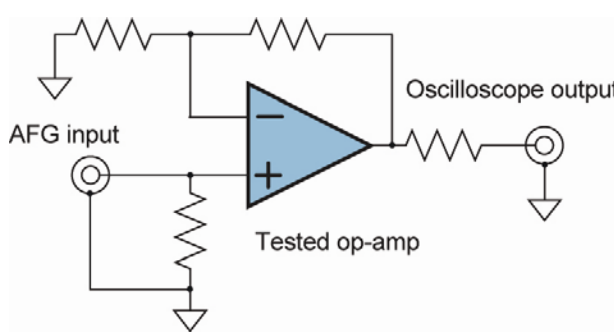


Figure 1: Slew rate measuring circuit.
The AFG3000 Series arbitrary/function generator is connected to the op-amp input and the TDS5000 Series “digital phosphor oscilloscope” is connected to the output.

Consideration of measurement procedures and results

In the first example the fall time of the AFG3000 Series is set to a maximum speed (2.5 ns) and the rise time is gradually increased. In this case the output begins to oscillate when the rise time reaches 32 ns.

In the next example, with the rise time held constant at 32 ns, the pulse fall time is gradually increased. As Figure 4 shows, the falling flank of the op-amp output now starts to oscillate where the fall time reaches approximately 20 ns.

This example shows that the op-amp has asymmetric characteristics. It would be wrong to simply assume that the op-amp's response to rising and falling edges is identical. In the actual application, these differences in the op-amp's response could lead to malfunctions.

In the last example, the op-amp's output signal is observed while the rise time and fall time are reduced,. For this amplifier, although the transition time becomes short, the output certainly becomes “clean”. As shown in Figure 5, the cleanest transition response occurs when the rise and fall time are set to 2.5 ns. This is the smallest possible rise time for the AFG3000 Series.

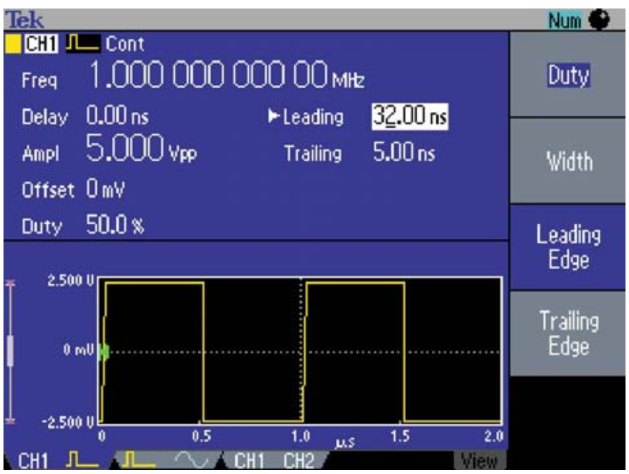


Figure 2: AFG setting screen
The waveform parameters can be adjusted.

These measurements lead to the conclusion that the rise time of the input signal of this amplifier should be under 32 ns and the fall time should be under 20 ns. Therefore, when the system input to the op-amp exceeds these values, it is necessary to select different settings which match the signal environment.

In the majority of op-amp applications, the conclusion that input signals should have fast rising edges is not obvious at first glance. The voltage change rate (dV/dt) of the op-amp output signal is limited to the op-amp slew rate and any other changes cannot be tracked.

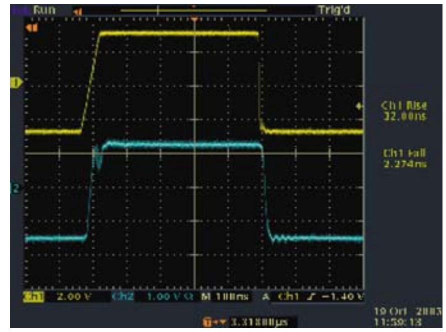


Figure 3: Input and output waveforms 1
The pulse rise time is increased until the point where the op-amp output starts to oscillate.

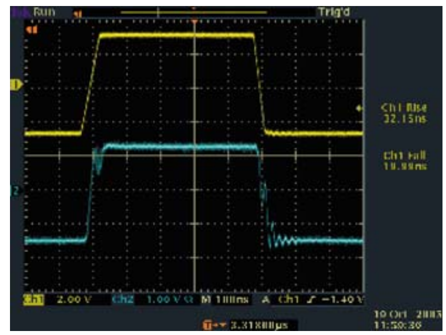


Figure 4: Input and output waveforms 2
While the pulse rise time is held constant, the fall time is being increased.

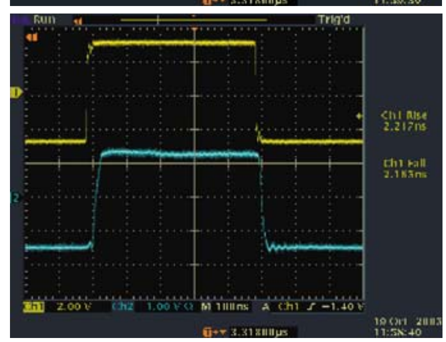


Figure 5: Input and output waveforms 3
This op-amp must be used with input signal rise times shorter than 32 ns and fall times below 20 ns.

Therefore, it is common to operate in the range where the voltage change rate does not exceed the slew rate. These examples, however, show that it is essential to understand the dynamics of the op-amp’s heterogeneous slew rate. They also show how advantageous it is to have a signal generator with separate settings for edge rise and fall times.

These examples only show a small portion of the wide variety of functions of the AFG3000. Also under different test conditions, the AFG meets the requirements of designers with uncompromised performance, and provides solutions for a wide range of applications.