

Tutorial: Arbitrary Function Generator (AFG) Usage

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In this document, a brief introduction to the use of an Arbitrary Function Generator is provided. The use of AFG to generate standard waveforms and some controls to change the parameters of those waveforms are also described. This document is a simpler version of AFG3000 series user manual.

1 What is an Arbitrary/ Function generator?

Arbitrary/ Function generators are electronic instruments used to generate time-varying electrical waveforms. Unlike function generators which generate standard waveforms such as sine, square, ramp, triangle etc., AFGs can also generate arbitrarily shaped waveforms. It also has AM/FM/PM modulation capabilities, sweep and burst modes. The waveform and its parameters are displayed in the graphic display.

2 The Tektronix AFG3000 series Arbitrary/Function generator

A representation of the front panel of 3000 series AFG is shown in Figure 1.

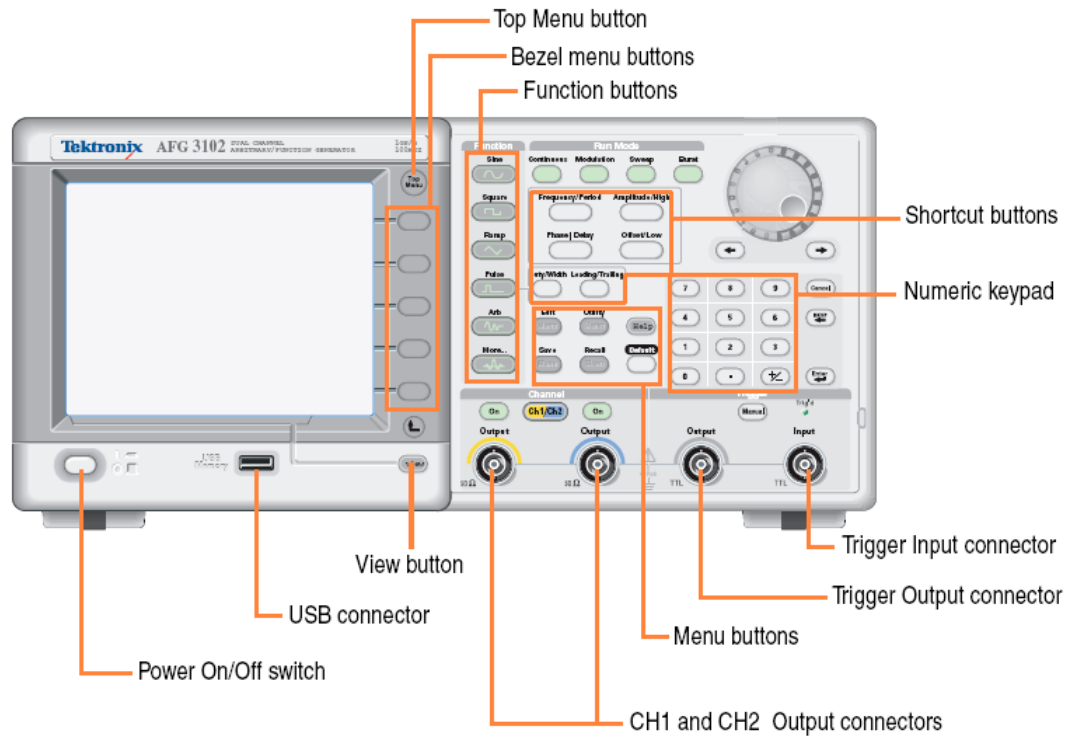


Figure 1: Dual channel arbitrary function generator

3 Using the AFG output

AFG has an output impedance (Z_S) of 50 ohm. Therefore the load impedance (Z_L) forms a voltage divider, along with Z_S . The voltage across the load ($V_{effective}$) is as shown in Figure 2.

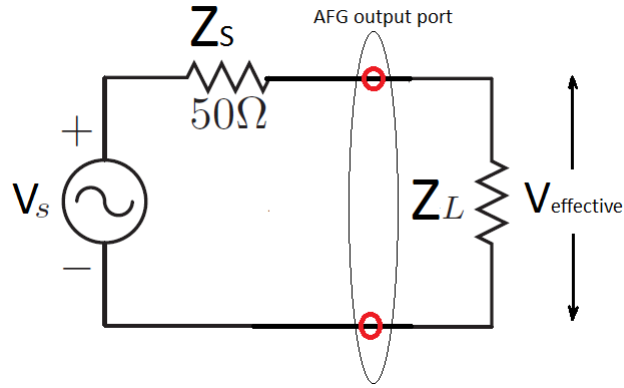


Figure 2: Effective voltage across load changes with it's impedance

By default, AFG generates V_S assuming that the load impedance is 50 ohm. Thus, for a voltage setting of 1V on AFG panel, V_S generated is equal to 2V. And for Z_L of 50 ohm, $V_{effective}$ is equal to 1V (as expected).

Loading AFG output with much greater impedance than 50 ohm (such as connecting the output directly to an oscilloscope), will drop majority of the voltage across the load. Thus $V_{effective}$ can be up to double the panel setting.

Whereas, loading AFG with $Z_L < 50$ ohm, can cause $V_{effective}$ to be less than the panel setting.

4 AFG Load Impedance setting

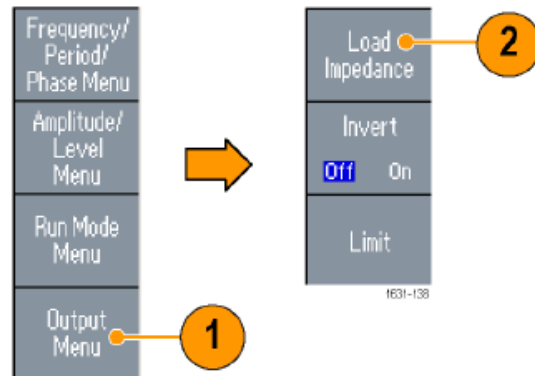
AFG is often used to generate an input signal for amplifiers. Amplifier circuits (with high input impedance) load AFG with a large Z_L . With default setting, AFG generates V_S twice the voltage set on the panel. Thus, $V_{effective}$ would be almost twice of the AFG panel setting, and the load circuits would receive unintended high input voltage.

A solution to this problem is, setting AFG load impedance to HIGH-Z. With this setting AFG generates V_S equal to the panel setting (as very low drop is expected across Z_S). And thus $V_{effective}$ would be almost equal to the panel setting.

If the input impedance of the load circuit is known, AFG load impedance can also be set to this specific value. With this setting, AFG precisely generates V_S , such that $V_{effective}$ is equal to the panel setting.

The load impedance of AFG can be adjusted to **HIGH-Z** (this is the setting required for most of our circuits) as per the process shown below in Figure 3.

1. Push the front-panel Top Menu button, and then push the Output Menu bezel button. The Output Menu is displayed.
2. Push Load Impedance to display the Load Impedance submenu.



3. To adjust the load impedance, select Load.
4. You can set the load impedance to any value from 1 Ω to 10 k Ω .
5. When the load impedance is set to other than 50 Ω , the set value is displayed in the output status.

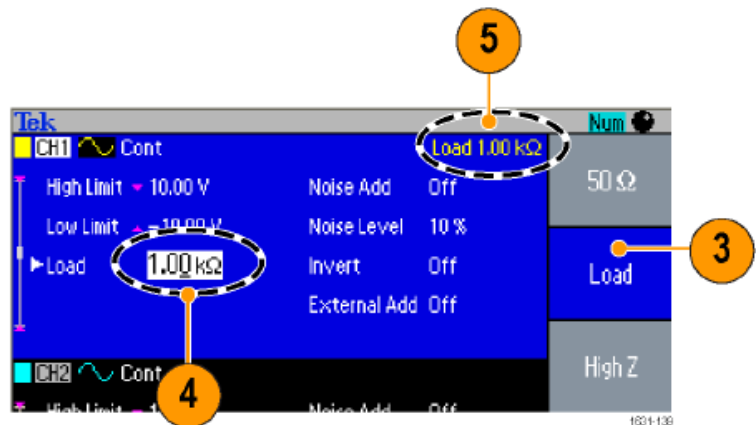
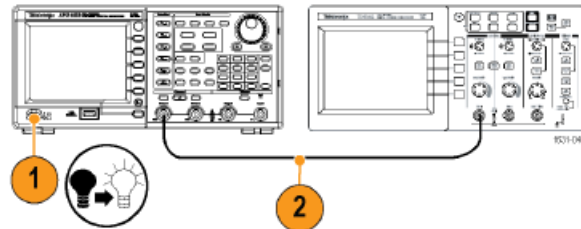


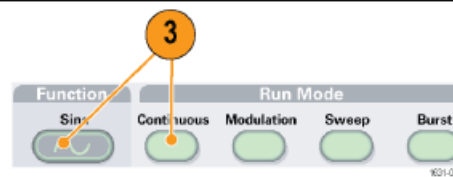
Figure 3: AFG load impedance setting

5 Generating a Sinusoid

1. Connect the power cord, and then push the front-panel power on/off switch to turn on the instrument.
2. Connect a BNC cable from the CH1 Output of arbitrary function generator to an oscilloscope input connector.



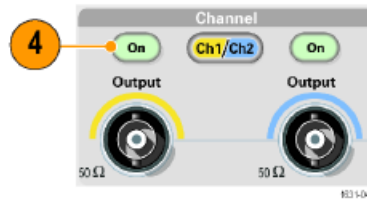
3. Push the front-panel Sine button, and then push the Continuous button to select a waveform.



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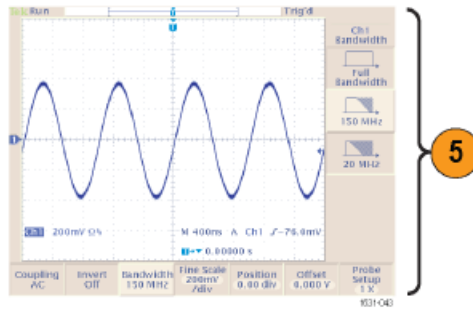
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4. Push the front-panel CH1 Output On button to enable the output.

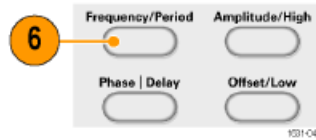


5. Use the oscilloscope auto-scaling function to display the sine waveform on the screen.
- If the instrument outputs a default sine waveform, you can manually set the oscilloscope as follows:

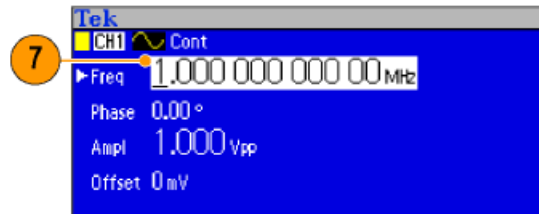
- 0.5 $\mu\text{s}/\text{div}$
- 200 mV/div



6. To change the frequency, push the front-panel Frequency/Period shortcut button.



7. The Frequency/Period/Phase Menu is displayed and Freq is selected. You can now change the frequency value.



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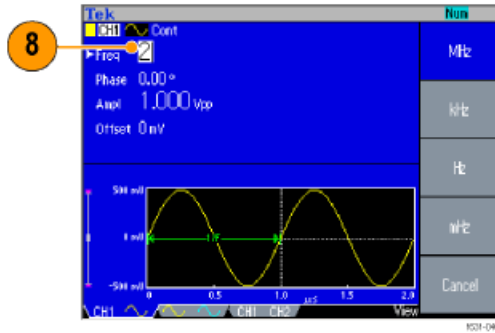
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8. To change the frequency value, use the keypad and Units bezel buttons.

For example, if you enter a value "2" using the keypad, the bezel menus will automatically change to Units.

After entering the frequency value, push the Units bezel button or the front-panel Enter button to complete the entry.

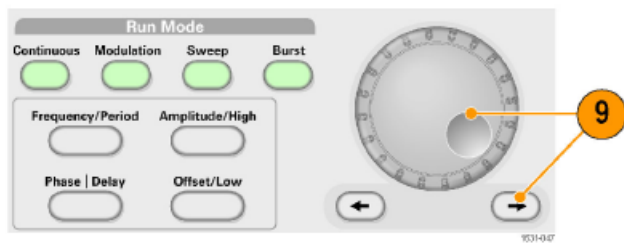
You can change the Amplitude, Phase, and Offset values in the same way.



9. You can also change the frequency value using the general purpose knob and the arrow keys.

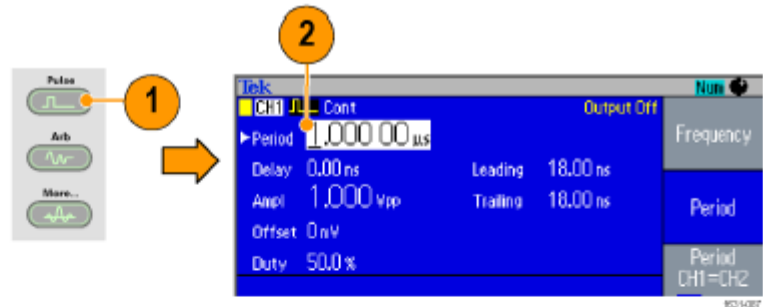
To increase the value, turn the knob clockwise.

To change a specific digit, select it by pushing the arrow keys. Then change it by turning the knob.

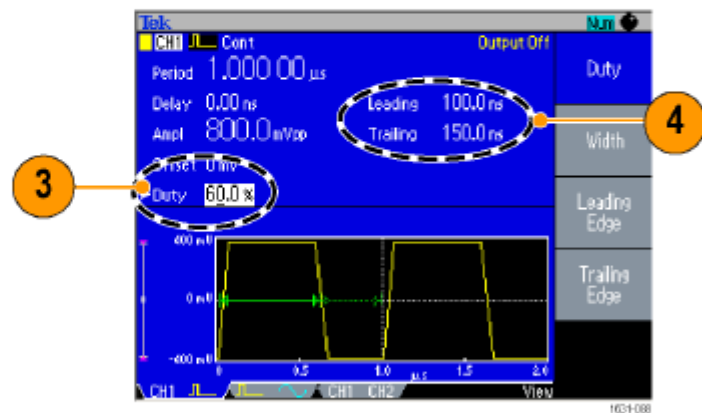


6 Generating a pulse waveform

1. Push the front-panel Pulse button to display the Pulse screen.
2. Push the Frequency/Period shortcut button to select Frequency or Period.



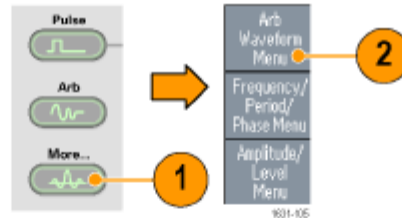
3. Push the Duty/Width shortcut button to toggle between Duty and Width.
4. Push the Leading/Trailing shortcut button to toggle the parameters for Leading Edge and Trailing Edge.



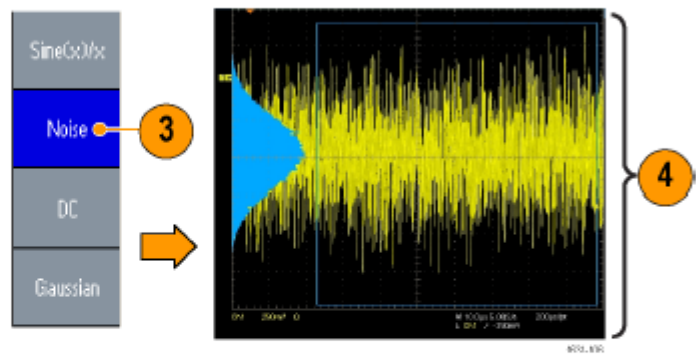
5. You can set the lead delay by pushing the Phase | Delay shortcut button to display the lead delay setting screen and adjusting the parameter as needed. You can also select Lead Delay from the bezel menu.

7 Generating a DC or Noise signal

1. Push the front-panel More... button.
2. Push the More Waveform Menu bezel button.



3. Select Noise.
4. You can set waveform parameters for Noise. This is a sample of Gaussian Noise displayed on an oscilloscope screen.



5. Push DC to display DC parameters.



8 Advanced usage of AFG

AFG can also generate arbitrarily shaped waveforms. It has AM/FM/PM modulation capabilities along with frequency sweep and burst mode output. Reader is advised to refer the equipment manual for understanding these functionalities.

9 References

- [1] <https://www.tek.com/signal-generator/afg3000-function-generator-manual/afg3000-series-arbitrary-function-generators>
- [2] <http://www2.ece.rochester.edu/courses/ECE111/xyzsofsignalsources.pdf>