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Introduction to the Oscilloscope & Function Generator

Analog Function Generator
INSTEK GFG-8215A

Digital Oscilloscope
HP 54602B 150MHz Oscilloscope

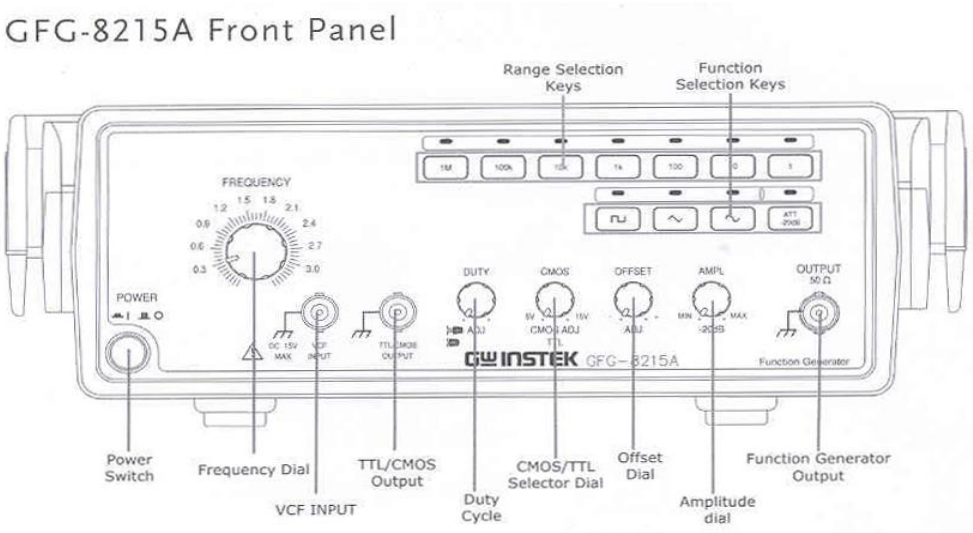
A Quick Guide to Using the Analog Function Generator

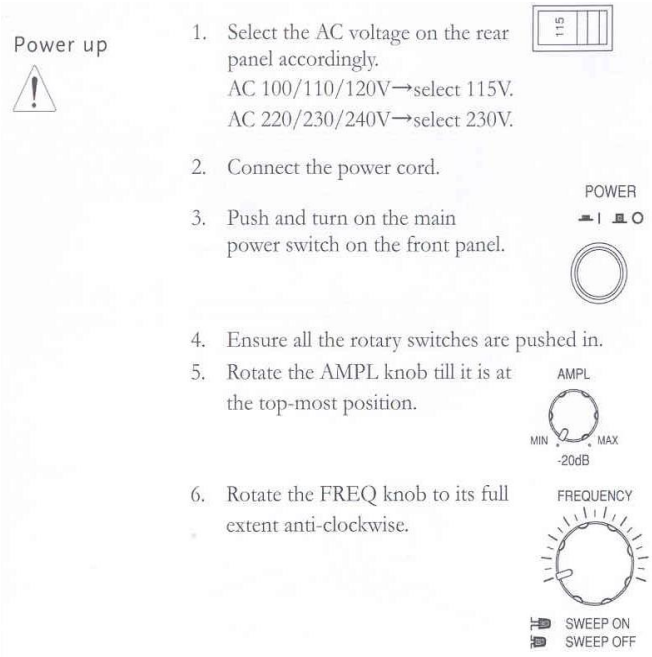
Introduction

The Analog Function Generator is an electronic device which can provide a variety of voltage waveforms, e.g., square, triangle, sine, and pulse waveforms, over a wide frequency range. It's widely used in system design, identification, testing, and repairing.

Controls and Indicators

The figure below shows the front panel of FG-8215A Function Generator by INSTEK Corp. Note that some features described below may not be available all models.





Waveform Generation

Waveform

1. Press square, triangle or sine waveform button

Sine waveform.

Square waveform.

Triangle waveform.

Range

2. Select the range. 1M-1 Hz.

Frequency

3. Rotate the frequency knob to the desired frequency. The frequency will be displayed on the LED display.

Output

4. Connect the FG to an input (oscilloscope).

Amplitude

5. Adjust the amplitude to the desired amplitude.

Attenuation

6.  Pull the AMPL knob out and adjust the attenuation if desired up to -20dB.

7. Furthermore the attenuation can be increased by pressing the ATT -20dB button.

Duty cycle

8.  Pull the Duty Cycle knob and rotate to adjust the duty cycle.

Waveform types

Square Wave 50% Duty cycle

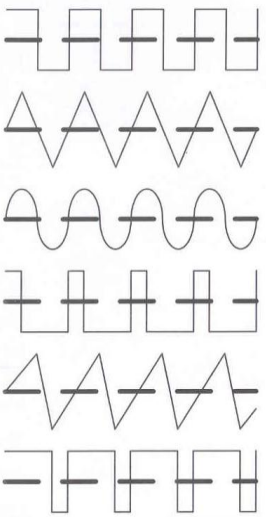
Triangle Wave 50% Duty cycle

Sine Wave 50% Duty cycle

Pulse Wave 30% Duty cycle

Ramp Wave 30% Duty cycle

Gated Pulse 70% Duty cycle



TTL/CMOS Output

Background

The GFG-8200A FG series are able to output TTL & CMOS Output.

1. Connect the FG to an appropriate device using the CMOS/TTL output terminal

2. Setup the FG to output a waveform. See page26.

3. Push/pull the TTL/CMOS knob to select the output type.

 Pushed: TTL is selected as output.

 Pulled: CMOS is selected as output.

The waveform is output is as follows:

TTL: ≥3Vp-p (fixed)

CMOS: 4V±1Vp-p ~ 14.5±0.5Vp-p

This particular model is capable of providing the waveforms over a frequency range of 0.3 Hz to 3 MHz, plus a VCF (voltage-controlled frequency) input, variable DC Offset, and TTL / CMOS pulse output. The following is the description of all the controls and indicators (refer to diagram).

Power Switch
The power switch applies power to the function generator.

Power-On Indicator
A light-emitting diode (LED) is used to indicate when power is applied to the function generator.

Range Selection Keys
Seven fixed decades of frequency – 1 Hz to I MHz – are provided by the range push buttons. Each of the seven range push buttons is interlocked. Depressing one pushbutton will release all others. When a key has been pressed a LED will light above the pressed key to indicate selection.

Function Selection Keys
Three interlocking push-button switches provide selection of the desired output waveform: square, triangle, and sine waveforms. When a key has been pressed a LED will light above the pressed key to indicate selection. Pressing the ATT -20 dB key will attenuate the signal by -20 dB, i.e., the signal amplitude will be reduced by a factor of 10.

Frequency Dial
The frequency dial allows frequency settings between fixed ranges. Although the dial skirt is calibrated from 0.3 to 3.0, the dynamic rage of the frequency dial is 1000:1 (three decades). For example, this allows frequency settings between 300 KHz and 3000 Hz without changing ranges.

Duty Cycle Dial
Time symmetry of the output waveforms is controlled by the duty cycle dial. When the duty cycle dial is pushed in, the duty cycle is 50%. When the dial is pulled out, the duty cycle can be adjusted from 30% to 70%. The variable symmetry allows the time period of one half the waveform to be changed while the other half remains fixed as determined by range and multiplier settings. This unique feature provides ramp waveforms, variable pulse width and variable duty cycle pulses, and skewed sine waves.

DC Offset
A DC offset control is provided to allow the DC level of the output waveforms to be set as desired. When the button is pushed in, there is no offset. When the button is pulled out, DC offset adjustment is enabled – CCW is negative and CW is positive. Note that the amount of offset plus the amplitude setting cannot exceed the maximum peak-to-peak amplitude or clipping will occur.

Amplitude / Attenuation Control

When the dial is pushed in, the waveform amplitude can be set – CCW decreases the amplitude and CW increases the amplitude. When the dial is pulled out, the waveform amplitude is attenuated by up to -20 dB – CCW decreases the attenuation and CW increases it.

Output

Square, triangle, sine, ramp and pulse waveforms are provided at up to $10V_{pp}$ amplitude (open circuit) at the output.

VCF Input

A VCF (voltage-controlled frequency) input is provided for externally sweeping the frequency. Approximately +10V applied at the VCF input will sweep the generator frequency down three decades or 1000:1. The generator may also be swept up in frequency by applying a negative voltage at the VCF input.

Pulse Output

The pulse output is a TTL 3 V_{pp} output signal or a CMOS 4-14.5 V_{pp}. The rise- and fall-time of the pulse output is typically 10ns. The pulse width, repetition rate, and symmetry may be set as pulse output is controlled in the same manner as the waveforms.

A Quick Guide to Using the HP Digital Oscilloscope

An oscilloscope is a voltage measuring device capable of displaying the voltage signals versus time. The Hewlett Packard 54601A oscilloscope offers several analysis features which previously required hand calculations. The following guide describes the basic features of this oscilloscope and also some useful analysis features. Numbers in **bold** will indicate a button on the control panel.

Connecting a signal to the oscilloscope

Before connecting any inputs, be sure the target signal is 400 V or less, as this is the maximum limit of the oscilloscope. Also remember, the oscilloscope cannot measure current, only voltages. Another word of caution, the ground on an oscilloscope is a real ground, unlike a multimeter. This means that if the ground on the oscilloscope is connected to a voltage on a device, it will short the voltage to ground. The 54601A (54602B is shown – same family of oscilloscopes) has four input channels. Channels 3 and 4 are normally not used, because they are limited in capability in comparison to channels 1 and 2. Connect a lead to channel 1 and press **1**. A menu appears at the bottom of the screen with 6 options.

- **On/Off** - turns the channel on or off
- **Coupling** - DC is used for the total signal, AC filters out constant voltages, the last symbol is ground
- **BW Lim** - if on, it will filter out high frequency noise
- **Invert** - this will invert the signal about the ground reference (see Setting the Vertical Scale)
- **Vernier** - allows the volts/div (see Setting the Vertical Scale) to be adjusted in smaller increments

- **Probe** - some probes have an attenuation associated with them, such as a *x10* probe; this setting allows the oscilloscope to display the correct measurements for such a probe. For a *x10* probe, set the probe setting to 10.

Triggering

Triggering is used to place a signal on the display in a desired location. Here's an example. If a square wave were being monitored and no triggering was being used, the signal would look as if it were scrolling across the screen. Triggering says: if a certain threshold level is passed, place that trigger point on the signal at this point on the screen. All other portions of the signal are then put on the screen in reference to that one trigger point. This makes the signal appear as if it is standing still on the screen.

The trigger **Source** menu allows you to select channels 1-4 or Line (60 Hz, outlet). Normally you will trigger with the signal you are measuring, or if you are measuring two signals with the same frequency, either can be used. The trigger **Mode** is the method by which the oscilloscope will trigger. Of the five modes, normally only the first four are used. **Auto Level** sets the scope's trigger point to be the 50% amplitude point on the displayed waveform. **Auto** will produce a baseline display if trigger conditions are not met. **Normal** is as described above and **Single** will trigger only once and display that one waveform. The trigger **Level** knob adjusts the threshold level for triggering.

Setting the Vertical Scale

The vertical scale corresponds to the measurement of voltage. The **Position** knob adjusts the ground reference, or 0 volts, of the signal being measured. This can be used to center a signal with a DC offset. This adjustment will not affect the automatic voltage measurements as described in the Measurements section.

The **Volts/Div** knob determines the scale with which you are measuring the signal. Remember, this does not affect the signal, only the scale with which you are viewing it. For example, in viewing a signal that is 5V, with a scale of 5V/div, the signal would have an amplitude of one block. With a scale of 10V/div, the signal would have an amplitude of half a block. In each case, the signals are 5V in amplitude, just viewed with different scales.

Setting the Horizontal Scale

The horizontal scale is a measurement of time. It is used much in the same way as the voltage scale is used. The **Delay** knob adjusts the signal left and right on the time scale. It can be used to look at portions of the signal more closely. The **Time/Div** adjusts the time scale. Higher frequency signals must be viewed with smaller time/div scales and lower frequency signals must be viewed with larger time/div scales.

Making Measurements

There are two ways to make measurements on the oscilloscope. First there are functions which automatically measure and calculate desired data. These are contained in the menus under the **Voltage** and **Time** buttons. These menus are similar in that a source must be selected and then the type of measurement desired. Make sure the source is the signal to be measured. Once a

measurement is selected it will be displayed at the bottom of the screen. A maximum of three measurements can be displayed at once. On the second menu of each measurement function there is a **Show Meas** button. This will display cursors demonstrating the measurement being taken.

The second method of measurement is the **Cursor**. In this menu, a source must also be selected. It is important the signal being measured is chosen as the source, otherwise the data recorded could be in error. Select a cursor to be moved, **V1**, **V2**, **t1**, or **t2**, and then move it with the unlabeled knob below the measurement keys. With this method, unusual or special measurements can be made manually.

Display/Printing

The **Display** menu allows the display mode to be changed. **Normal** displays the wave form as it is received, **Peak Det** allows detection of signal extremes, and **Average** will average a selectable number of waveforms before it is displayed.

Also on the **Display** menu is the **Vector** button. When **Vector** is on and the **Stop** button is pressed, the display basically connects the dots making a more vivid waveform. This is useful when printing. The **Grid** button allows you to change the type of grid to be displayed on the screen.

Under the Print menu, the commonly used features are obviously **Print Screen** and **Clear Menu**. To print the screen, first press the **Stop** button and then use the **Print Screen** function. The **Clear Menu** button does as it says, clears the menu from the bottom of the screen.