

Equipment Introduction:

Part I - Introduction to the Function Generator

Overview:

The function generator is used to generate a wide range of alternating-current (AC) signals. A diagram of the Leader LFG-1300S Function Generator is shown below in Figure 1.

- The front panel is divided into six major control groups:
 - 1) Frequency Selection Group;
 - 2) Sweep Group;
 - 3) Amplitude Modulation Group;
 - 4) DC Offset Group;
 - 5) Function, or Waveform Group; and
 - 6) Output Group.

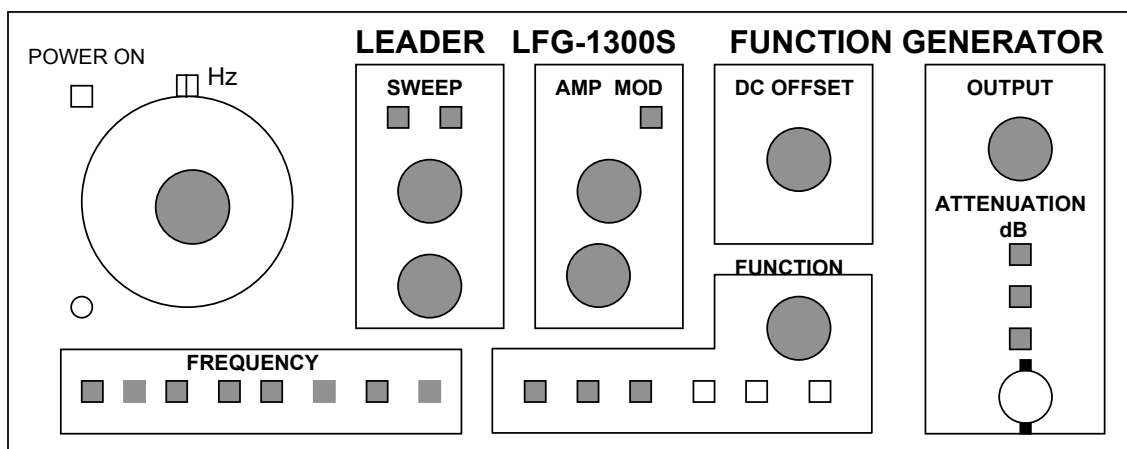


Figure 1. Front Panel of Function Generator

- The power switch is on the upper left-hand corner of the unit. The green LED will indicate that the unit is on.
- The three most important groups for this lab are the **frequency**, **function**, and **output groups**. The remaining three groups, (**sweep**, **amplitude modulation**, and **DC offset**) will be briefly covered in the lab setup procedures. Should you desire more detailed descriptions of these groups, the Leader Function Generator manual is available in the lab.

Frequency Selection Group:

These controls are used to select the operating frequency of the function generator. This group consists of the frequency control knob and the eight frequency multiplier selection buttons.

For example, to set the function generator to an operating frequency of 2000 Hz (2 kHz):

- Rotate the frequency control knob to 2.
- Select the 1 kHz frequency multiplier button.

With the result that: $2.0 * 1 \text{ kHz} = 2.0 \text{ kHz}$.

To set the function generator to an operating frequency of 5.5 kHz:

- Rotate the frequency control knob to 0.55.
- Select the 10 kHz frequency multiplier button.

With the result that: $0.55 * 10 \text{ kHz} = 5.5 \text{ kHz}$.

Output Group:

1. These controls are used to adjust the amplitude of the generator's output signal. The group consists of the **amplitude-control knob**, the three **attenuation buttons** and the fused 50 ohm **BNC connector**.

- Although the amplitude knob is not indexed, the amplitude ranges from a few millivolts to approximately 20 volts.
- We will set the amplitude levels by aligning the white line on the amplitude knob to the three o'clock position (90 degrees right), the nine o'clock position (90 degrees left), or the twelve o'clock position (straight up).
- Notice that rotating the knob fully to the left does not result in a zero amplitude signal.
- The attenuation buttons are used to attenuate (decrease) the amplitude of the signal by a factor measured in decibels. The following relationship will assist in working with the attenuation buttons:

$$(\text{dB}) = -10 * \log_{10} (P_{\text{out}} / P_{\text{in}}) \quad (\text{if } \textit{power} \text{ is the unit of measurement})$$

or

$$(\text{dB}) = -20 * \log_{10} (V_{\text{out}} / V_{\text{in}}) \quad (\text{if } \textit{voltage} \text{ is the unit of measurement})$$

- Example:

Given a 1 volt input signal, what is the change in voltage amplitude if the 10 dB attenuation button is depressed?

Beginning with the equation defined above:

$$(\text{dB}) = -20 * \log_{10} (V_{\text{out}} / V_{\text{in}})$$

$$10\text{dB} = -20 * \log_{10} (V_{\text{out}} / V_{\text{in}})$$

$$-0.5 \text{ dB} = \log_{10} (V_{\text{out}} / V_{\text{in}})$$

$$10^{-0.5} = V_{\text{out}} / V_{\text{in}}$$

$$V_{\text{out}} / V_{\text{in}} = 0.3162$$

- From here, the output voltage can be stated in terms of the input voltage and vice-versa:

$$V_{\text{in}} = V_{\text{out}} / 0.3162$$

or

$$V_{\text{out}} = V_{\text{in}} * 0.3162$$

Since the initial input voltage (V_{in}) was 1 volt the output voltage (V_{out}) must be 0.3162V or 316 millivolts.

- **Note:** The attenuation buttons are additive. In other words, if the 10 dB and the 20 dB buttons are both pressed in, the combined attenuation of the input signal is 30 dB.

2. The fused 50 ohm BNC connector is used for connecting the function generator to other equipment. The most common connection used to connect the function generator to other equipment is a cable with a BNC connector on one end and two *alligator* clips on the other end.

- One end of the cable, the base, is used to connect the cable to the BNC connector on the function generator. The other end, which has two 'alligator' clips: one positive (red) and one negative (black), is used to connect the function generator to the device or circuit under study.
- To connect the cable to the function generator:
 1. Hold the cable's BNC connector, the base, in one hand.
 2. Line up the two grooves on the cable's BNC connector with the two pegs on the outside of the function generator's BNC connector.
 3. Push the cable's BNC connector over the function generator's BNC connector until it is fully seated.
 4. Rotate the cable's BNC connector in a clockwise manner until it is firmly secured to the function generator's BNC connector.

Function/Waveform Selection Group:

This group is used to select the shape of the generated waveform. The group is made up of the six wave-selector buttons. The six waveforms that the function generator can produce are the **sine** wave, the **square** wave, the **triangle** wave, two **sawtooth** waves, and the **variable-width pulse** wave.

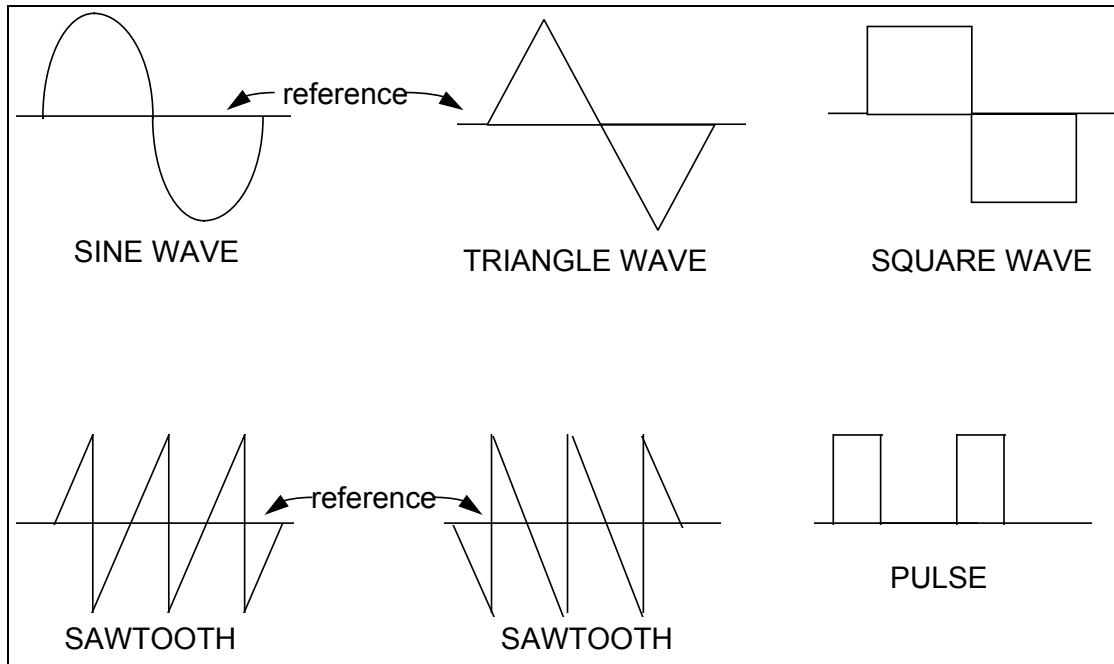


Figure 2: Available Generated Waveforms

- In this lab, you will become familiar with the three fundamental signals (waveforms), the **sine** wave, the **square** wave, and the **triangle** wave.

Waveforms:

This section will provide you with some background on waveforms and on measuring waveforms. It is especially important that you understand how to measure waveforms. This is a skill that is not only important to this lab, but also to the T-1 Lab and in labs for other Telecommunications Courses.

- There are two types of alternating-current signals, which are also called waveforms:
 - **Periodic**
 - **Non-periodic**
- Periodic** signals, such as sine or triangle waves, behave in a uniform manner and repeat themselves over a given length of time. Each repetition of a repeating signal is called a **period** or a **cycle**.

- **Non-periodic** signals, such as analog voice, behave in a non-uniform manner and do not repeat themselves over any given length of time.

Note: In this lab, we will only work with periodic signals.

- When working with AC signals, there are three properties of the signal that we are concerned with: **amplitude**, **period** and **frequency**.
- The **amplitude** of the wave is defined as the maximum magnitude of the wave. The amplitude is the vertical component of the signal and is measured in units of volts (V). Since we are dealing with an AC signal, the voltage will change over a period of time. The maximum voltage of a signal during its cycle is commonly referred to as the **peak voltage (V_p)**.
- The amplitude can be measured from the reference line to the peak (V_p) or from peak-to-peak (V_{pp}). See Figure 3 below.

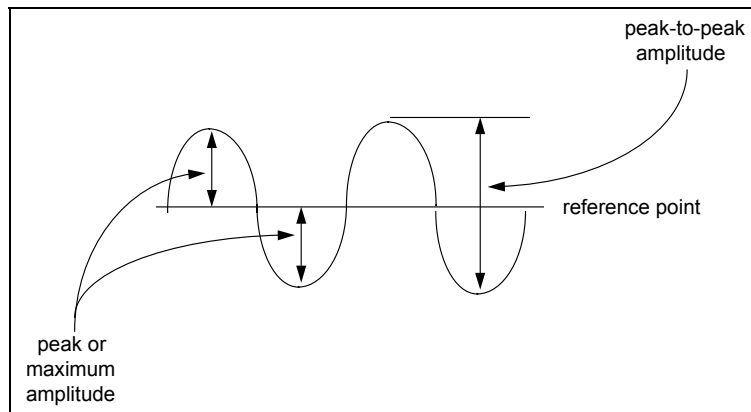


Figure 3: Measuring Amplitude.

- With a periodic signal that is symmetrical (equi-distant above and below the reference point), the peak-to-peak voltage is equal to twice the peak voltage:

$$V_{pp} = 2 * V_p$$

- The **period (T)** of the signal is defined as the time it takes for a signal to complete one full **cycle**. The period is the horizontal component of the signal, measured in units of seconds (s). In Figure 4, the period of the signal is measured as 250 milliseconds (250.0×10^{-3} s).

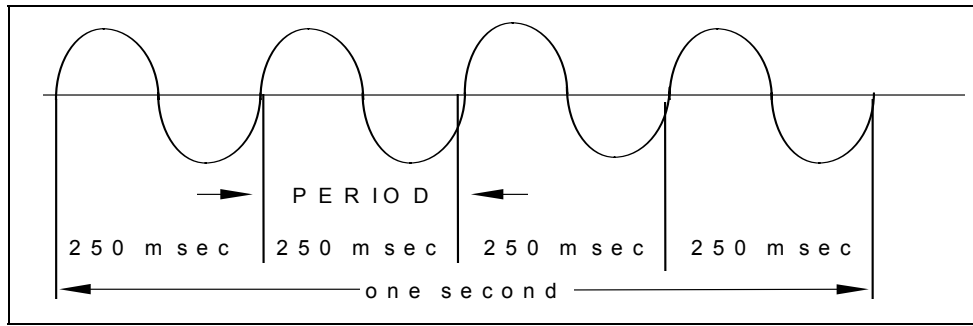


Figure 4: Measuring Period.

- The **frequency (f)** of the signal is defined as the rate at which a periodic signal repeats. It is usually measured in units of **Hertz (Hz)**, where 1 Hz = 1 cycle per second.
- In Figure 4, above, you can see four(4) cycles occurring within one second; therefore, the signal has a frequency of 4 Hz.
- The frequency, *f*, of a wave is inversely related to its period (*T*):

$$f = 1 / T$$

- Example:

The period of the signal is 250 milliseconds, therefore the frequency of that signal is:

$$f = 1 / T$$

$$f = 1 / 250 \text{ milliseconds}$$

$$f = 4 \text{ Hertz}$$

Abbreviation	Prefix Name	Factor
T	Tera	10 ¹²
G	Giga	10 ⁹
M	Mega	10 ⁶
K	Kilo	10 ³
m	milli	10 ⁻³
μ	micro	10 ⁻⁶
n	nano	10 ⁻⁹
p	pico	10 ⁻¹²

Table of Scientific Prefixes