UNIT - #2 [3]

Signal Generators

The term oscillator is used to describe an instrument that provides only a sinusoidal o/p signal.

The term Generator is used to describe an instrument that provides several o/p w/f's including sine wave, square wave, triangular wave & pulse trains.

In contrast with oscillators that generate only the specific signals required by the instrument, the class of generator are available as separate instruments to provide signals for general test purposes are usually designated as signal generators.

Applications

signal generators are used for checking the stage gain, freq response & alignment in receivers.

They provide a variety of w/f's for testing electronic circuits.

AF & RF generators are designed to provide extensive & continuous coverage ~~over~~ a wide range of

frequencies.

The freq band limits are.

Band.	Approximate Range.
AF	20Hz – 20KHz
RF	above 30KHz
VLF	15 – 100KHz.
LF	100 – 500KHz.
Broad cast	0.5 – 1.5MHz.
Video	DC – 5MHz
HF	1.5 – 30MHz.
VHF	30 – 300MHz
UHF	300 – 3000MHz
microwave	beyond 3000MHz (3GHz).

Most service type AF generators cover from 20Hz to 200KHz.

In advanced lab types of AF generators, the freq range extends a bit further 5Hz – 600KHz (HP model – Hewlett Packard) & marconi model generator both sine & square waves & has wide range of 10Hz – 10MHz.

Fixed freq AF oscillator

In most signal generator circuits, oscillator ckt is an integral part of the circuitry. This oscillator is used to generate a signal at some specified audio freq.

fixed freq might be a 400Hz signal used for audio testing or a 1000Hz signal used for Exciting a bridge ckt.

oscillations at a specified audio frequencies are easily generated by the use of iron core transformer to obtain +ve F/B thro' inductive coupling betwn primary & secondary windings.

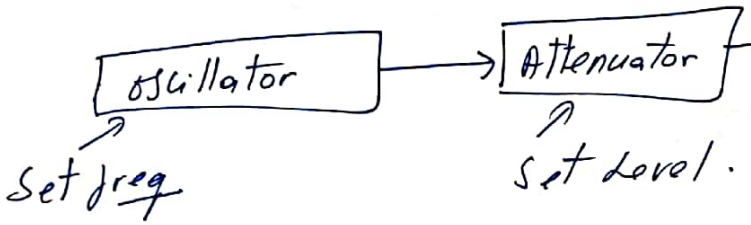
Variable AF oscillator.

A Variable AF osc for general purpose used in lab should cover at least the full range of audibility (20Hz to 20KHz) & should have constant pure sinusoidal wave o/p over the entire freq range.

Variable freq AF generators used for lab use are of the RC f/b osc type or Beat freq osc type.

Basic standard signal generator (sine wave)

This instrument covers a freq range from a few Hz to many Giga Hz. The sine wave generator in its simplest form consists of an oscillator & a attenuator



The proper functioning of a signal generator depends on the performance of an osc & attenuator.

standard signal Generator

It is extensively used in the testing of radio receivers & transmitters.

It is used as a power source for the measurements of gain, s/N ratio, B.W, standing wave ratio & other properties.

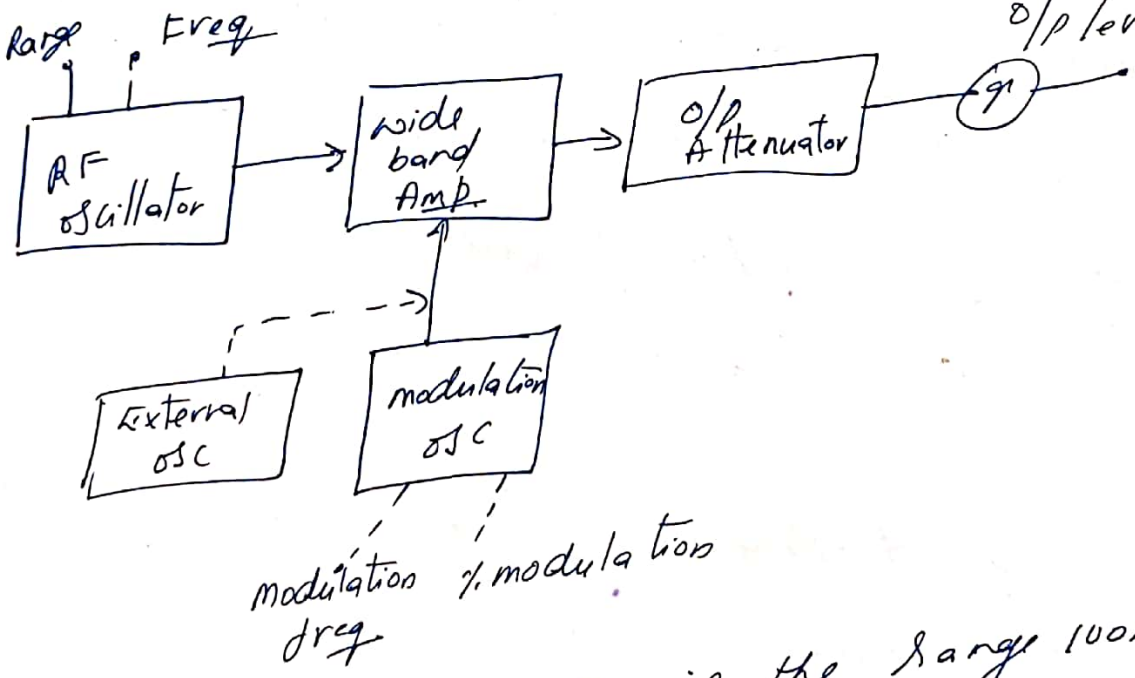
This signal generator is also capable of modulating its sinusoidal o/p signal with other signals.

when the signal generators are employed for

producing an unmodulated sinusoidal o/p they are said to be continuous wave signal.

when the produced o/p signal is modulated, the modulating w/f may be either Externally applied sine waves, square waves, Δlar waves, pulses etc,, ∴ the o/p signal can be Amplitude modulated or Freq modulated.

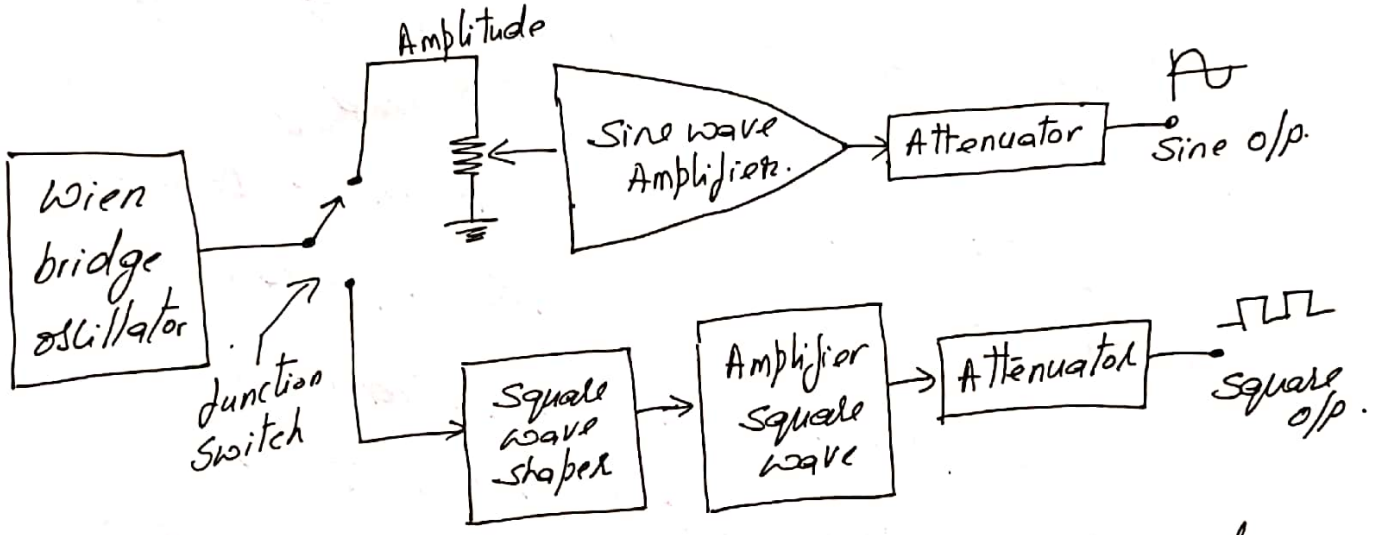
The elements of a signal generator are shown in fig.



The carrier freq in the range 100KHz to 30MHz is generated by a stable RF oscillator using an LC tank circuit, which is having a constant o/p. over the freq range. The freq of oscillations is indicated by the freq range control & the vernier

isolate the oscillator circuit from the o/p circuit. This isolation is necessary, so that changes in the o/p circuit do not affect the oscillator frequency and amplitude. Therefore Buffer amplifiers are used.

AF Sine & Square wave generator.



A wien bridge oscillator is used in this generator. This oscillator is best for the audio frequency range. The frequency of oscillations can be changed by varying the capacitance in the oscillator. The frequency can also be changed in steps by switching in resistors of different values.

The output of oscillator goes to the function switch. This switch directs the oscillator

output either to the sine wave amplifier or to the square wave shaper. At the output, we get either a square or sine wave. The output is varied by means of an attenuator.

The instrument generates a frequency ranging 10Hz to 1MHz, continuously variable in 5 decades with overlapping ranges. The output sine wave amplitude can be varied from 5mV to 5V (rms). The o/p is taken through a push-pull amplifier. For low output, the impedance is 600Ω.

The square wave amplitudes can be varied from 0-20V (peak). It is possible to adjust the symmetry of the square wave from 30-70%. The instrument requires only 7W of power at 220V-50Hz.

The front panel of signal generator consists of

1] Frequency Selector :-

It selects the frequency in different ranges and varies it continuously in a ratio

of 1:11.

2] Freq multiplier :- It selects the freq range over 5 decades from 10Hz to 1MHz.

3] Amplitude multiplier :- It attenuates the sine wave in 3 decades, x1, x 0.1 & x0.01

4] Variable amplitude :- It attenuates the sine wave amplitude continuously.

5] Symmetry control :- It varies the symmetry of the square wave from 30% to 70%.

6] Amplitude :- It attenuates the square wave o/p continuously

7] Function switch :- It selects either sine wave or square wave o/p.

8] o/p ~~test~~ available :- This provides sine wave or square wave o/p.

9] Synch :- This terminal is used to provide synchronisation of the internal signal with an external signal

10] on-off switch.

Function Generator

A function generator produces different w/f's of adjustable freq. The common o/p w/f's are the sine, square, triangular & sawtooth waves. The freq may be adjusted, from a fraction of a Hz to several hundred KHz.

The various o/p's of the generator can be made available at the same time. For example, the generator can provide a square wave to test the linearity of an amplifier and simultaneously provide a sawtooth to drive the horizontal deflection amplifier of the CRO to provide a visual display.

Capability of phase lock.

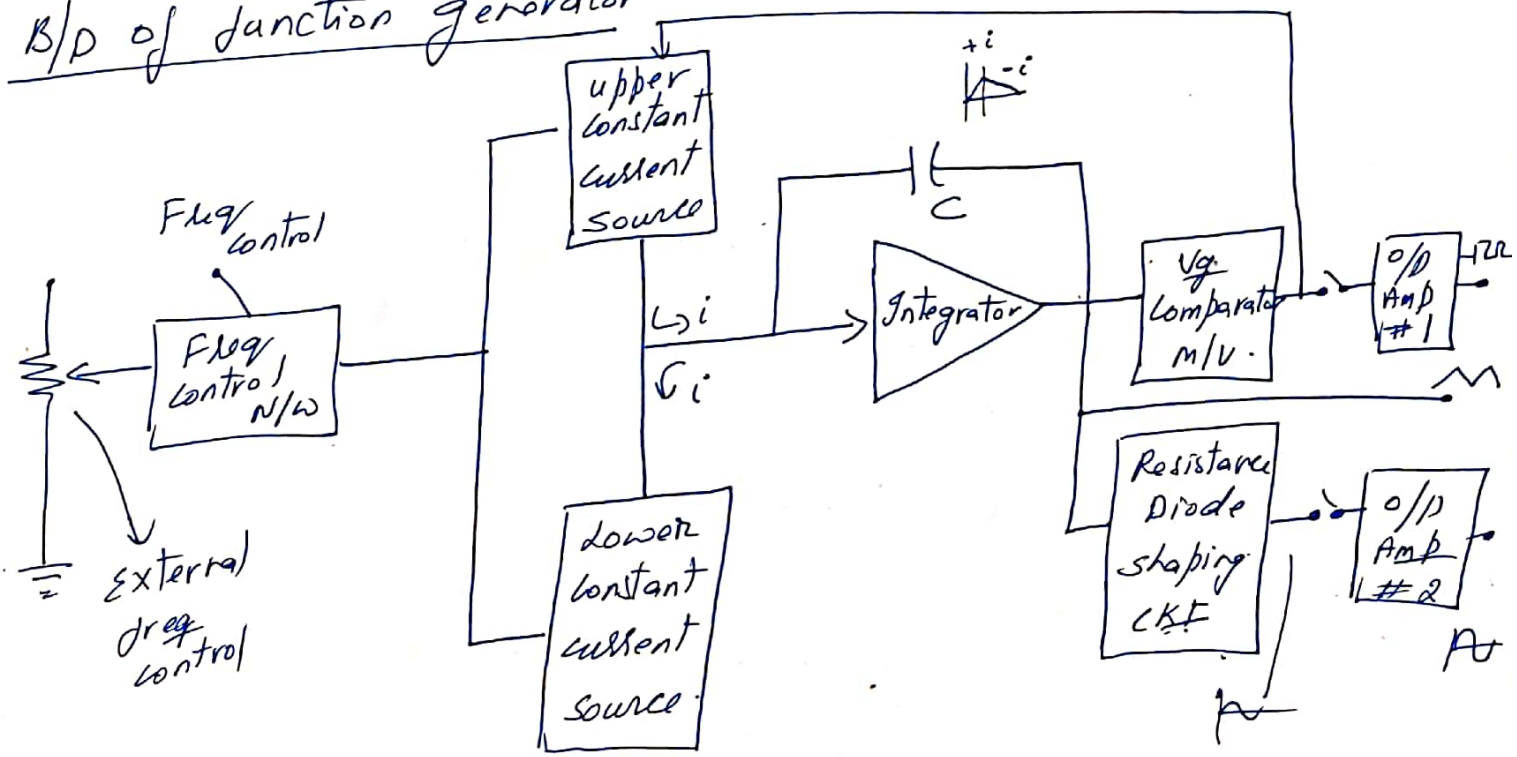
The function generator can be phase locked to an external source. one function generator can be used to lock a second function generator & the two o/p signals can be displaced in phase by adjustable amount.

In addition, the fundamental freq of one generator can be phase locked to a harmonic of another generator, by adjusting the amplitude & phase of the harmonic, almost any w/f can be generated

by addition.

The function generator can also be phase locked to a freq std and all its o/p w/f's will then have the same accuracy & stability as the std source.

B/D of function generator



Usually the freq is controlled by varying the capacitor in the LC or RC CKT. In this instrument the freq is controlled by varying the magnitude of current which drives the integrator. The instrument produces sine, triangular and square waves with a freq range of 0.01Hz to 100KHz.

The freq controlled Vg regulates two current sources. The upper current source supplies constant current to the integrator whose o/p Vg increases

linearly with time, according to the equation of the o/p signal v_g.

$$e_{out} = -\frac{1}{C}\int_0^t i\,dt.$$

An increase or decrease in the current increases or decreases the slope of the o/p v_g & hence controls the freq.

The v_g comparator multivibrator changes states at a predetermined max level of the integrator o/p v_g. this change cuts off the upper current supply & switches on the lower current supply.

The lower current source supplies a reverse current to the integrator, so that its o/p decreases linearly with time. when the o/p reaches a pre-determined min level, the v_g comparator again changes state & switches on the upper current source.

The o/p of the integrator is a triangular w/f. whose freq is determined by the magnitude of the current supplied by the constant current sources

The comparator o/p delivers a square wave v_g of the same freq. The resistance diode N/w alters the slope of the triangular wave as its amplitude changes & produces a sine wave with less

than 1% distortion.

Square & pulse generator (Lab type)

These generators are used as measuring devices in combination with a CRO. They are used in testing of amplifier. The fundamental difference between a pulse generator & a square wave generator is in the duty cycle

$$\text{Duty cycle} = \frac{\text{Pulse width}}{\text{Pulse period}}.$$

A square wave generator has a 50% duty cycle.

Requirements of a pulse

1) The pulse should have min distortion.
2) The basic chs of the pulse are rise time, overshoot, ringing, sag & undershoot
3) The pulse should have sufficient max Amplitude
4) The range of freq control of the pulse repetition rate (PRR) should meet the needs of the experiment for eg, a repetition freq of 100MHz is required for testing fast ckts
5] pulse generators can be used to produce trigger signals, when this o/p is passed thro a

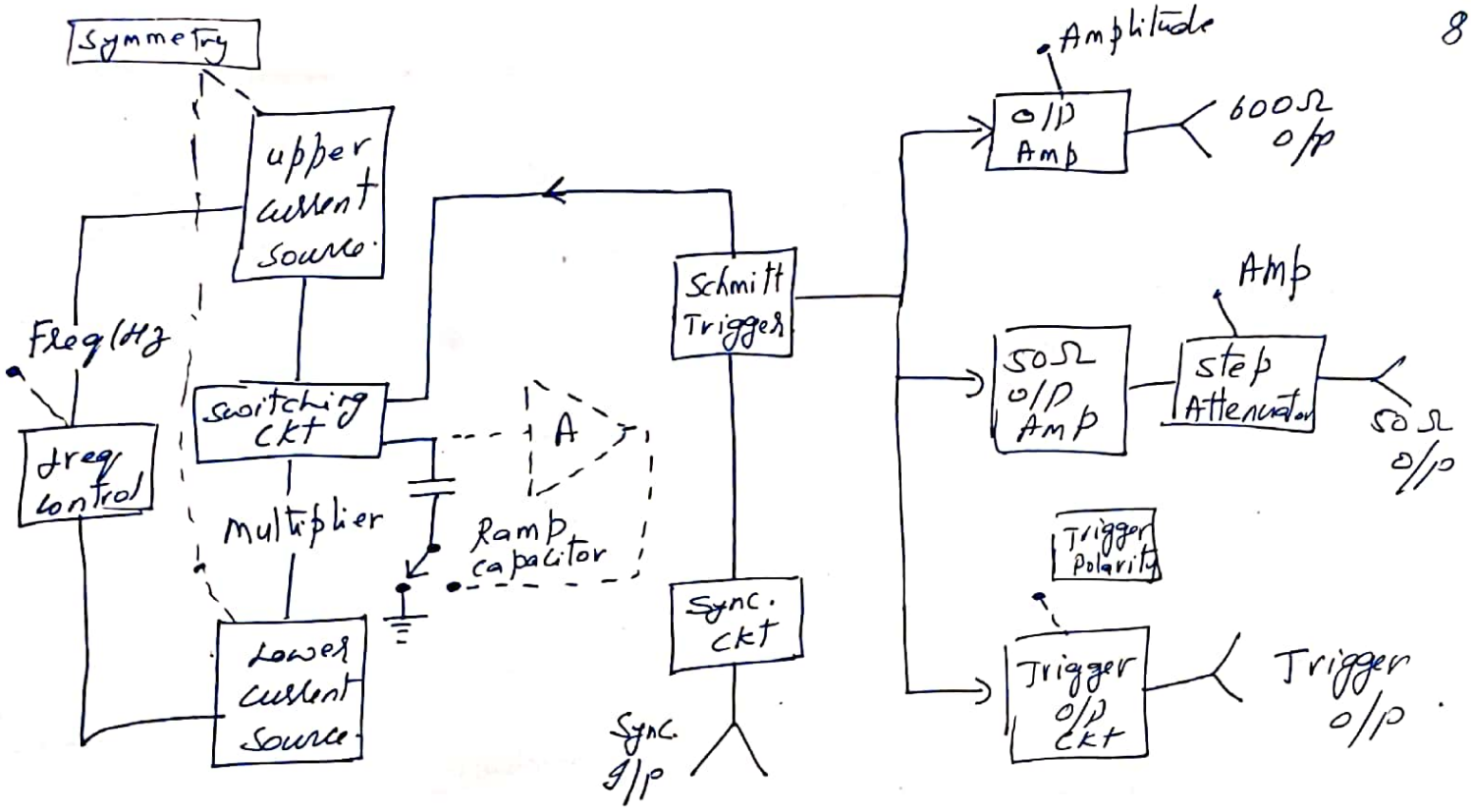
differentiator ckt.

6] The o/p impedance of the pulse generator is important. In a fast pulse system, the generator should be matched to the cable & cable to the test ckt. A mismatch would cause energy to be reflected back to the generator by the test ckt & this may be re-reflected by the generator, causing distortion of the pulses.

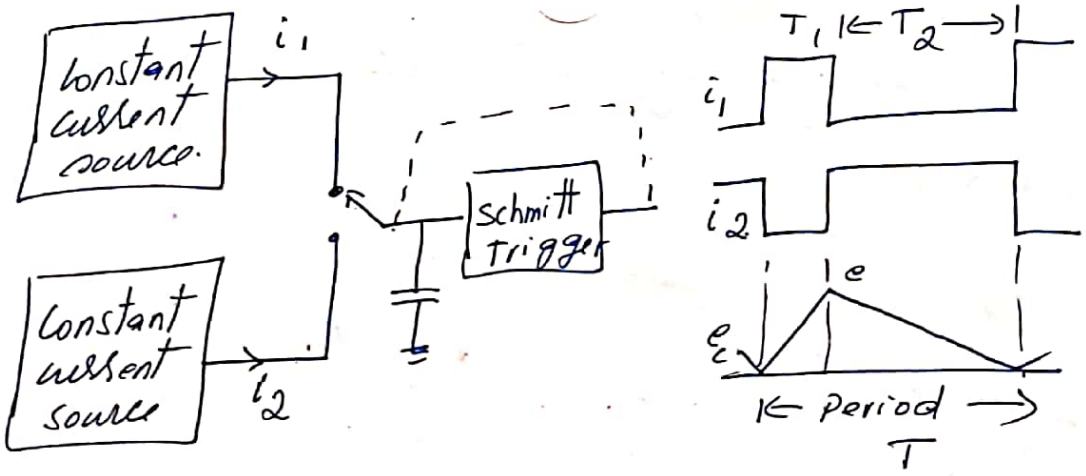
7). DC coupling of the o/p ckt is needed. when dc bias level is to be maintained.

B/p of a pulse generator

* The freq range of the instrument is covered in seven decade steps from 1Hz to 10MHz.
* The duty cycle can be varied from 25-75%.
* Two independent o/p's are available.
  a) a 50Ω source that supplies pulses with a rise & fall time of 5ns at 5V peak amplitude
  b) a 600Ω source that supplies pulses with a rise & fall time of 70ns at 30V peak amplitude.
* the instrument can be operated as a free running generator.



The Basic generating loop consists of the current sources, the ramp capacitor, the schmitt trigger and current switching ckt as shown in dig below



The upper current source supplies a constant current to the capacitor & the capacitor Vq increases linearly. when the +ve slope of the

ramp voltage reaches the upper limit set by the internal ckt components, the schmitt trigger changes state. The trigger ckt. o/p becomes -ve and reverses the condition of the current switch. The capacitor discharges linearly, controlled by the lower current source.

When the -ve ramp reaches the lower level, the schmitt trigger switches back to its original state. The entire process is then repeated.

The ratio i_1/i_2 determines the duty cycle, α is controlled by symmetry control. The sum of i_1 & i_2 determines the freq. The size of the capacitor is selected by the multiplier switch.

The unit is powered by an internal supply that provides regulated Vgs for all stages of the instrument.

Sweep freq Generators

The testing of the freq response of amplifiers & filters can be simplified & speeded up by using a signal generator that automatically varies its freq over a predetermined range. Such an