CMR INSTITUTE OF TECHNOLOGY	USN										

Improvement Examination

Sub:	Electronic Instrumentation							Code:	15EC35
Date:	20/ 11 / 2017	Duration:	90 mins	Max Marks:	50	Sem:	III	Branch:	ECE

Answer Any FIVE FULL Questions

		Marks	OBE CO	OBE RBT
1	With the help of necessary diagrams explain the working of a digital frequency meter.	[10]	CO2	L2
2	Draw the block diagram of a digital multi-meter. Explain the functionality of each block.	[10]	CO2	L2
3	Draw the block diagram of a simple CRO and explain the working	[10]	CO2	L2
4	Explain analog storage oscilloscope	[10]	CO2	L2
5	Obtain lissajous pattern for the given frequency relationship. a. $f_h= 3f_v$ b. $f_v= (3/2)f_h$	[10]	CO2	L3
6	Explain the working of a laboratory signal generator with the help of a neat block diagram. Comment on how frequency stability is ensured in the system.	[10]	CO2	L2
7	a. Explain the working of a square and pulse generator b. List down any four requirements of a pulse signal from a signal generator	[07] [03]	CO2 CO2	L2 L1
8	a. Explain the working of a sweep frequency generator. b. Explain the working of an AF sine and square wave generator.	[05] [05]	CO2 CO2	L2 L2

1. With the help of necessary diagrams explain the working of a digital frequency meter.

Digital frequency meter

The Principle of Operation of Digital Frequency Meter is given by

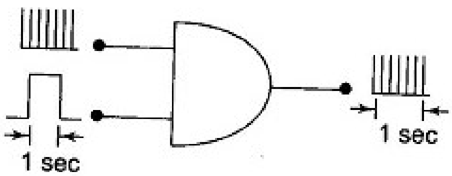


Fig. 2.1.

The signal waveform is converted to trigger pulses and applied continuously to an AND gate, as shown in Fig. 2.1. A pulse of 1 s is applied to the other terminal, and the number of pulses counted during this period indicates the frequency.

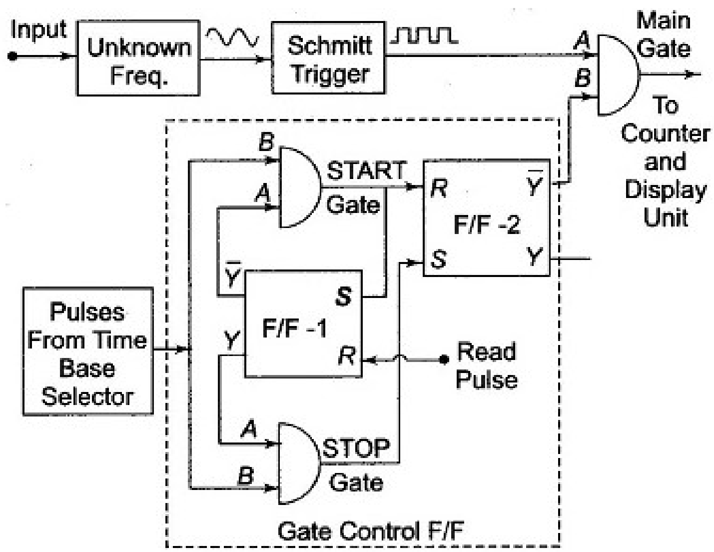
The signal whose frequency is to be measured is converted into a train of pulses, one pulse for each cycle of the signal. The number of pulses occurring in a definite interval of time is then counted by an electronic counter. Since each pulse represents the cycle of the unknown signal, the number of counts is a direct indication of the frequency of the signal (un-known). Since electronic counters have a high speed of operation, high frequency signals can be measured.

Block Diagram and Working:

The Schmitt trigger converts the input signal into a square wave with fast rise and fall times, which is then differentiated and clipped. As a result, the output from the Schmitt trigger is a train of pulses, one pulse for each cycle of the signal.

The output pulses from the Schmitt trigger are fed to a START/STOP gate. When this gate is enabled, the input pulses pass through this gate and are fed directly to the electronic counter, which counts the number of pulses.

When this gate is disabled, the counter stops counting the incoming pulses. The counter displays the number of pulses that have passed through it in the time interval between start and stop. If this interval is known, the unknown frequency can be measured.



Gate controlled Flip-Flop:

The output of the unknown frequency is applied to a Schmitt trigger, producing positive pulses at the output. These pulses are called the counter signals and are present at point A of the main gate. Positive pulses from the time base selector are present at point B of the START gate and at point B of the STOP gate.

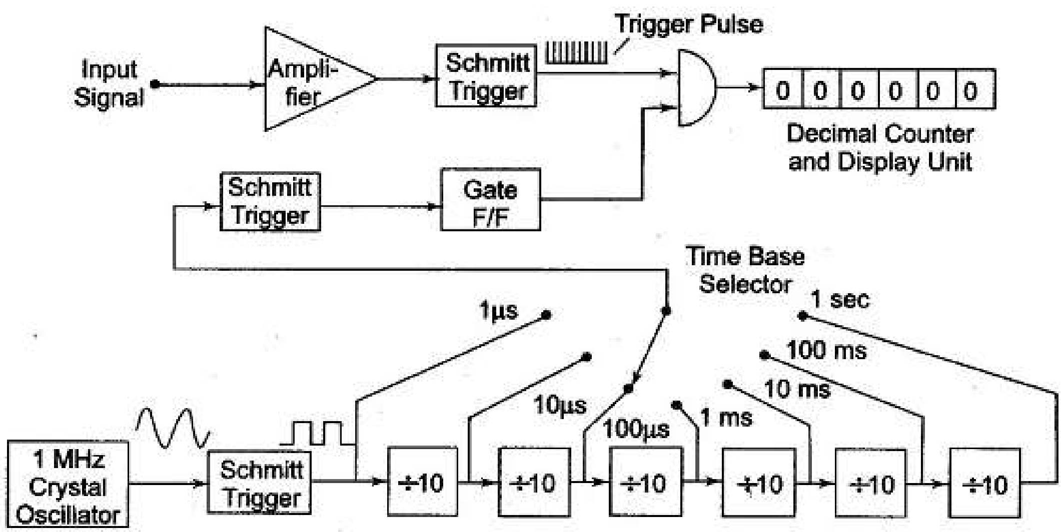
Initially the Flip-Flop (F/F-1) is at its logic 1 state. The resulting voltage from output Y is applied to point A of the STOP gate and enables this gate. The logic 0 stage at the output Y of the F/F-1 is applied to the input A of the START gate and disables the gate.

As the STOP gate is enabled, the positive pulses from the time base pass through the STOP gate to the Set (S) input of the F/F-2 thereby setting F/F-2 to the 1 state and keeping it there.The resulting 0 output level from Y of F/F-2 is applied to terminal B of the main gate. Hence no pulses from the unknown frequency source can pass through the main gate.

In order to start the operation, a positive pulse is applied to (read input) reset input of F/F-1, thereby causing its state to change. Hence Y = 1, Y= 0, and as a result the STOP gate is disabled and the START gate enabled. This same read pulse is simultaneously applied to the reset input of all decade counters, so that they are reset to 0 and the counting can start.When the next pulse from the time base arrives, it is able to pass through the START gate to reset F/F-2, therefore, the F/F-2 output changes state from 0 to 1, hence Y changes from 0 to 1. This resulting positive voltage from Y called the gating signal, is applied to input B of the main gate thereby enabling the gate.

Now the pulses from the unknown frequency source pass through the main gate to the counter and the counter starts counting. This same pulse from the START gate is applied to the set input of F/F-1, changing its state from 0 to 1. This disables the START gate and enables the STOP gate. However, till the main gate is enabled, pulses from the unknown frequency continue to pass through the main gate to the counter.The next pulse from the time base selector passes through the enabled STOP gate to the set input terminal of F/F-2, changing its output back to 1 and fi = 0. Therefore the main gate is disabled, disconnecting the unknown frequency signal from the counter. The counter counts the number of pulses occurring between two successive pulses from the time base selector. If the time interval between this two successive pulses from the time base selector is 1 second, then the number of pulses counted within this interval is the frequency of the unknown frequency source, in Hertz.

The block diagram of a digital frequency meter is shown in Fig. 2.3.



The first pulse activates the gate control F/F. This gate control F/F provides an enable signal to the AND gate. The trigger pulses of the input signal are allowed to pass through the gate for a selected time period and counted. The second pulse from the decade frequency divider changes the state of the control F/F and removes the enable signal from the AND gate, thereby closing it. The decimal counter and display unit output corresponds to the number of input pulses received during a precise time interval; hence the counter display corre-sponds to the frequency.

2. Draw the block diagram of a digital multi-meter. Explain the functionality of each block.

Digital meters offer high accuracy, have a high input impedance and are smaller in size. They gives unambiguous reading at greater viewing distances. The output available is electrical (for interfacing with external equipment), in addition to a visual readout.

All digital meters employ some kind of analog to digital (A/D) converters (often dual slope integrating type) and have a visible readout display at the converter output.

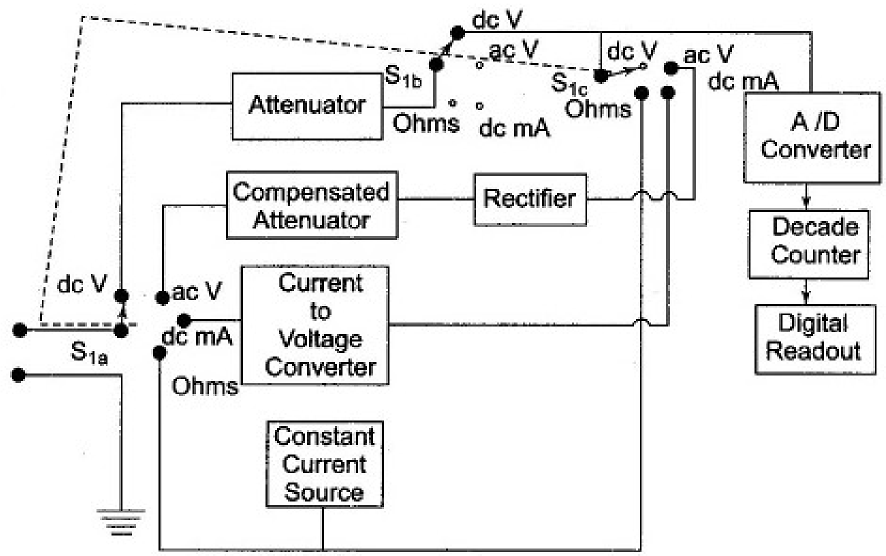


Fig 1.1 Block Diagram

A basic Digital Multi-meters (DMM) is made up of several A/D converters, circuitry for counting and an attenuation circuit. A basic block diagram of a DMM is shown in Fig. 1.1. It is basically a digital voltmeter, all parameters under measurement are converted to voltage and metered.

The current to voltage converter shown in the block diagram can be implemented with the circuit shown in Fig. 1.2. The current to be measured is applied to the summing junction (Σi) at the input of the op-amp. Since the current at the input of the amplifier is close to zero because of the very high input impedance of the amplifier, the current I_R is very nearly equal to I_i, the current I_R causes a voltage drop which is proportional to the current, to be developed across the resistors. This voltage drop is the input to the A/D converter, thereby providing a reading that is proportional to the unknown current.

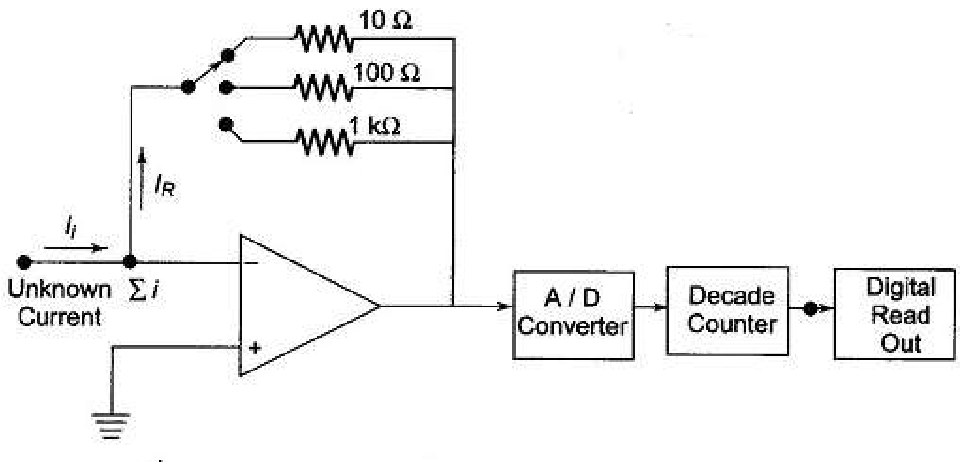
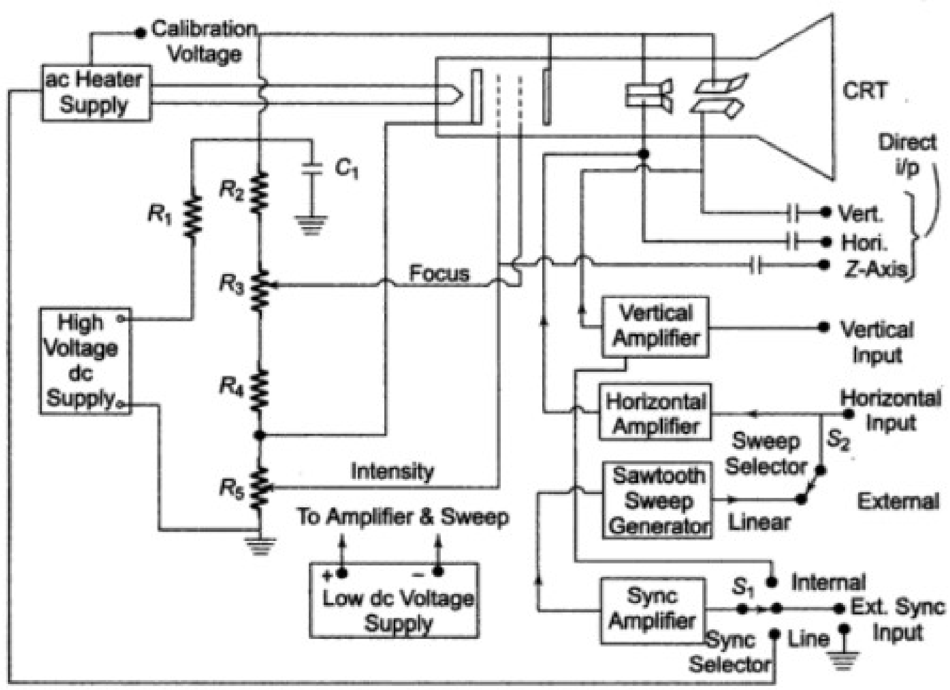


Fig 1.2 Current to voltage converter

Resistance is measured by passing a known current, from a constant current source, through an unknown resistance. The voltage drop across the resistor is applied to the A/D converter, thereby producing an indication of the value of the unknown resistance.

3. Draw the block diagram of a simple CRO and explain the working.

The basic block diagram of a simple CRO is shown in Fig. 7.5. The ac filament supplies power to the CRT heaters. This also provides an accurate ac calibrating voltage. CRT dc voltage is obtained from the HV dc supply through voltage dividers $R_1 - R_5$. Included along with this voltage divider is a potentiometer (R_3) which varies the potential at the focusing electrode, known as focus control, and one which varies the control grid voltage, called the intensity control (R_5).



Capacitor C_1 is used to ground the deflection plates and the second anode for the signal voltage, but dc isolates these electrodes from the ground.

Normally S_2 is set to its linear position. This connects the sweep generator output to the horizontal input. The sweep voltage is amplified before being applied to the horizontal deflecting plates.

When an externally generated sweep is desired, S_2 is connected to its external position and the external generator is connected to the input. The sweep synchronising voltage is applied to the internal sweep generator through switch S_1, which selects the type of synchronisation.

4. Explain analog storage oscilloscope

Storage targets can be distinguished from standard phosphor targets by their ability to retain a waveform pattern for a long time, independent of phosphor peristence. Two storage techniques are used in oscilloscope CRTs, mesh storage and phosphor storage.

A mesh-storage CRT uses a dielectric material deposited on a storage mesh as the storage target. This mesh is placed between the deflection plates and the standard phosphor target in the CRT. The writing beam, which is the focussed electron beam of the standard CRT, charges the dieletric material positively where hit. The storage target is then bombarded with low velocity electrons from a flood gun and the positively charged areas of the storage target allow these electrons to pass through to the standard phosphor target and thereby reproduce the stored image on the screen. Thus the mesh storage has both a storage target and a phosphor display target. The phosphor storage CRT uses a thin layer of phosphor to serve both as the storage and the display element.

Mesh Storage

It is used to display Very Low Frequencies (VLF) signals and finds many applications in mechanical and biomedical fields. The conventional scope has a display with a phosphor peristence ranging from a few micro seconds to a few seconds. The persistence can be increased to a few hours from a few seconds.

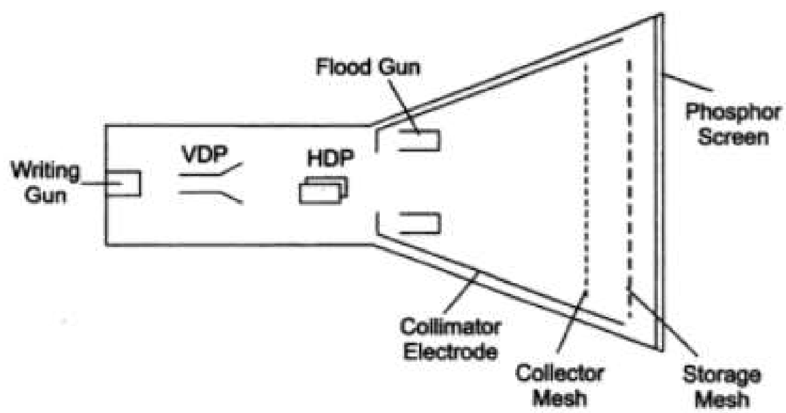


Fig. 7.26 ▬ Basic Elements of Storage Mesh CRT

A mesh storage CRT, shown in F'g. 7.26, contains a dielectric material deposited on a storage mesh, a collector mesh, flood guns and a collimator, in addition to all the elements of a standard CRT. The storage target, a thin deposition of a dielectric material such as Magnesium Fluoride on the storage mesh, makes use of a property known as secondary emission. The writing gun etches a positively charged pattern on the storage mesh or target by knocking off secondary emission electrons. Because of the excellent insulating property of the Magnesium Fluoride coating, this positively charged pattern remains exactly in the position where it is deposited. In order to make a pattern visible, a special electron gun, called the flood gun, is switched on (even after many hours). The electron paths are adjusted by the collimator electrode, which constitutes a low voltage electrostatic lens system (to focus the electron beam), as shown in Fig. 7.27. Most of the electrons are stopped and collected by the collector mesh. Only electrons near the stored positive charge are pulled to the storage target with sufficient force to hit the phosphor screen. The CRT will now display the signal and it will remain visible as long as the flood guns operate. To erase the pattern on the storage mesh, a negative voltage is applied to neutralise the stored positive charge.

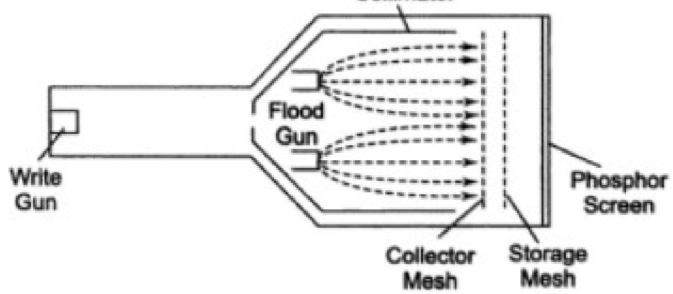


Fig. 7.27 Storage Mesh CRT

Since the storage mesh makes use of secondary emission, between the first and second crossover more electrons are emitted than are absorbed by the material, and hence a net positive charge results.

Below the first crossover a net negative charge results, since the impinging electrons do not have sufficient energy to force an equal number to be emitted. In order to store a trace, assume that the storage surface is uniformly charged and write gun (beam emission gun) will hit the storage target. Those areas of the storage surface hit by the deflecting beam lose electrons, which are collected by the collector mesh. Hence, the write beam deflection pattern is traced on the storage surface as a positive charge pattern. Since the insulation of the dielectric material is high enough to prevent any loss of charge for a considerable length of time, the pattern is stored. To view, the stored trace, a flood gun is used when the write gun is turned off. The flood gun, biased very near the storage mesh potential, emits a flood of electrons which move towards the collector mesh, since it is biased slightly more positive than the deflection region. The collimator, a conductive coating on the CRT envelope with an applied potential, helps to align the flood electrons so that they approach the storage target perpendicularly. When the electrons penetrate beyond the collector mesh, they encounter either a positively charged region on the storage surface or a negatively charged region where no trace has been stored. The positively charged areas allow the electrons to pass through to the post accelerator region and the display target phosphor. The negatively charged region repels the flood electrons back to the collector mesh. Thus the charge pattern on the storage surface appears reproduced on the CRT display phosphor just as though it were being traced with a deflected beam.

Figure 7.28 shows a display of the stored charge pattern on a mesh storage.

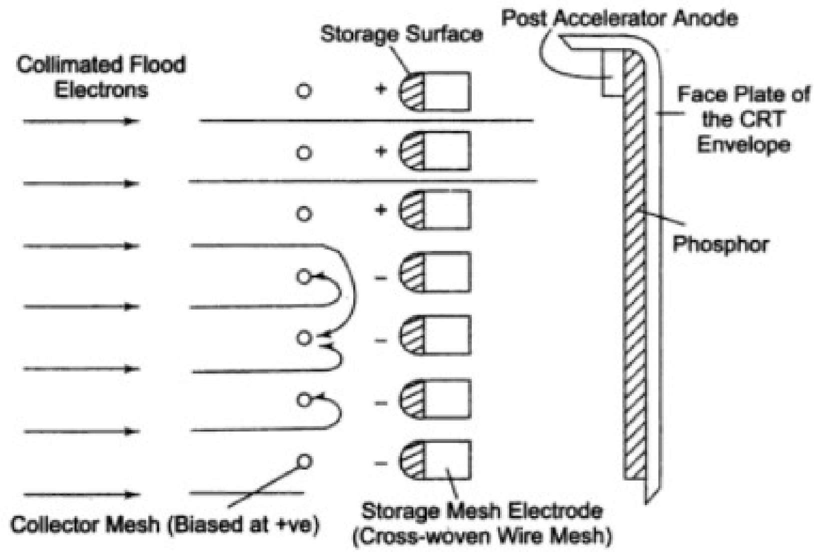


Fig. 7.28 Display of Stored Charged Pattern on a Mesh-storage

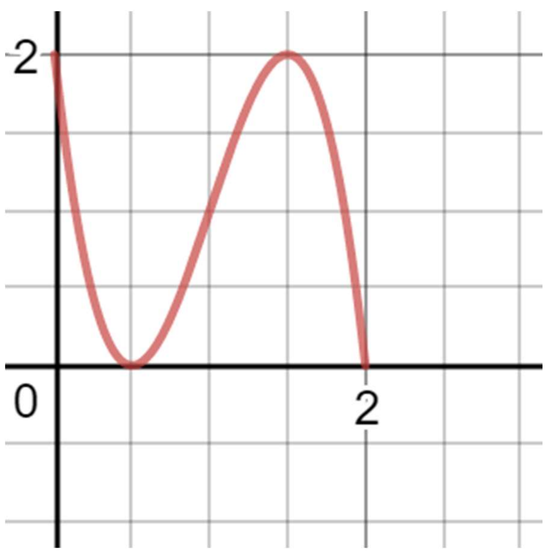
5.Obtain lissajous pattern for the given frequency relationship.

a. $f_h = 3f_v$

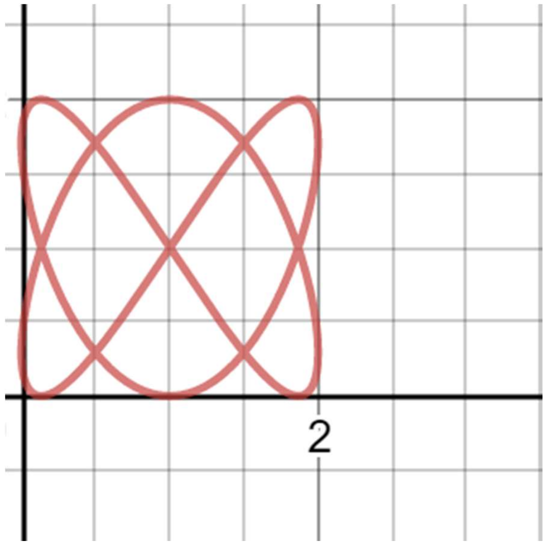
b. $f_v = (3/2)f_h$

Solution:

a. fh=3fv



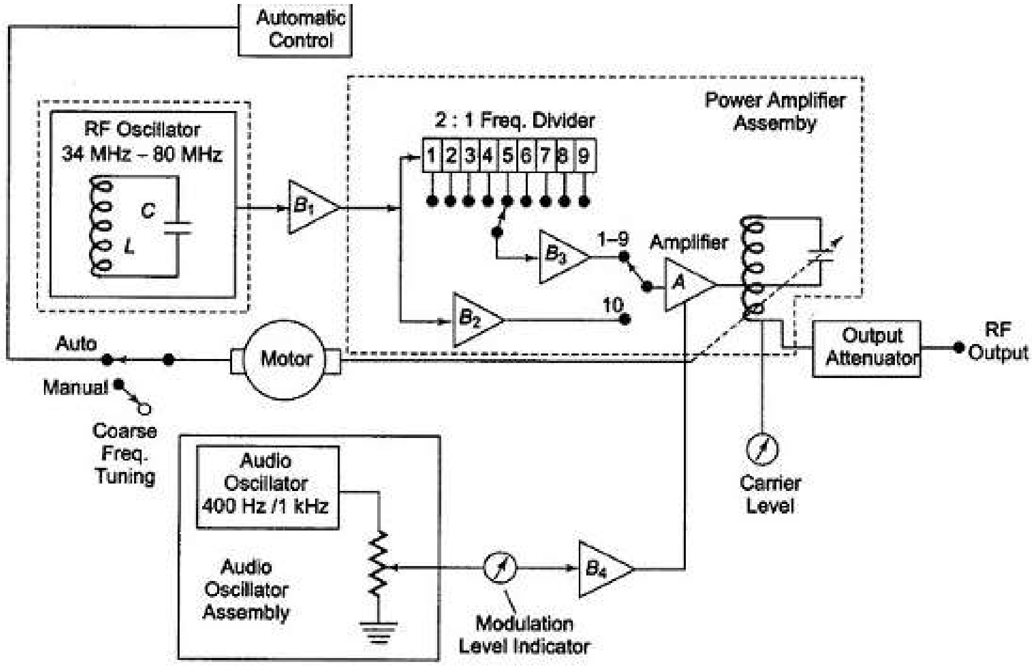
b. Fv=3/2fh



6. Explain the working of a laboratory signal generator with the help of a neat block diagram. Comment on how frequency stability is ensured in the system.

To improve the frequency stability compared to standard signal generator, a single master oscillator is optimally designed for the highest frequency range and frequency dividers are switched in to produce lower ranges. In this manner the stability of the top range is imparted to all the lower ranges.

The master oscillator is made insensitive to temperature variations and also to the influence of the succeeding stages by careful circuit design. Temperature compensation devices are used for any temperature changes. The block diagram of the modern standard signal generator is given in Fig. 7.1



The highest frequency range of 34 — 80 MHz, is passed through B1, buffer amplifier. B2 and B3 are additional buffer amplifiers and A is the main amplifier. The lowest frequency range produced by the cascaded frequency divider (9 frequency dividers of 2:1 ratio are used), is the highest frequency range divided by 512, or 29, or 67 — 156 kHz. Thus, the frequency stability of the highest range is imparted to the lower frequency ranges.The use of buffer amplifiers provides a very high degree of isolation between the master oscillator and the power amplifier, and almost eliminates all the frequency effects (distortion) between the input and output circuits, caused by loading.

Range switching effects are also eliminated, since the same oscillator is used on all bands. The master oscillator is tuned by a motor driven variable capacitor. For fast coarse tuning, a rocker switch is provided, which sends the indicator gliding along the slide rule scale of the main frequency dial at approximately 7% frequency changes per second. The oscillator can then be fine-tuned by means of a large rotary switch (control), with each division corresponding to 0.01% of the main dial setting.

The master oscillator has both automatic and manual controllers. The availability of the motor driven frequency control is employed for programmable automatic frequency control devices.Internal calibration is provided by the 1 MHz crystal oscillator. The small power consumption of the instruments makes it relatively easy to obtain excellent regulation and Q stability with very low ripple. The supply voltage of the master oscillator is regulated by a temperature compensated reference circuit.

The modulation is done at the power amplifier stage. For modulation, two internally generated signals are used, that is, 400 Hz and 1 kHz. The modulation level may be adjusted up to 95% by a control device. Flip-flops can be used as frequency dividers to get a ratio of 2:1.

7a.Explain the working of a square and pulse generator.

Square and Pulse Generator Block Diagram are used as measuring devices in combination with a CRO. They provide both quantitative and qualitative information of the system under test. They are made use of in transient response testing of amplifiers. The fundamental difference between a pulse generator and a square wave generator is in the duty cycle.

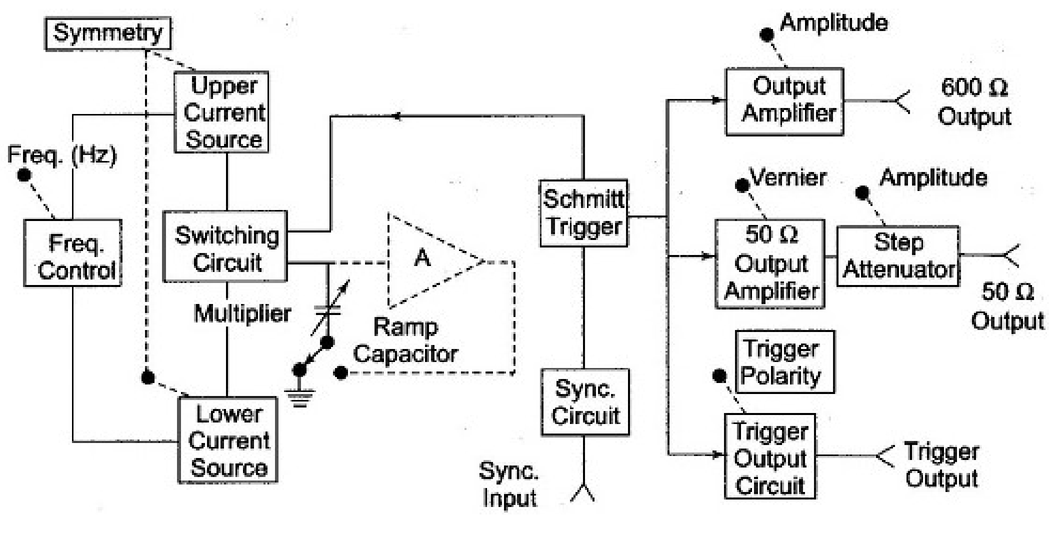
$$\text{Duty cycle} = \frac{\text{pulse width}}{\text{pulse period}}$$

A square wave generator has a 50% duty cycle.

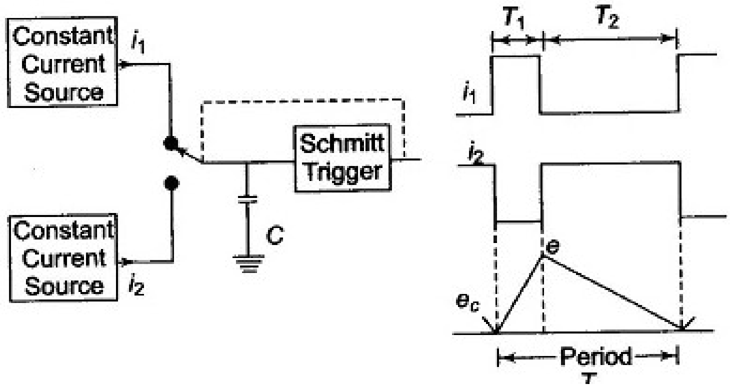
The basic circuit for pulse generation is the asymmetrical multi-vibrator. A laboratory type square wave and pulse generator is shown in Fig. 7.1

The frequency range of the instrument is covered in seven decade steps from 1 Hz to 10 MHz, with a linearily calibrated dial for continuous adjustment on all ranges.

The duty cycle can be varied from 25 – 75%. Two independent outputs are available, a 50 Q source that supplies pulses with a rise and fall time of 5 ns at 5 V peak amplitude and a 600 Q source which supplies pulses with a rise and fall time of 70 ns at 30 V peak amplitude. The instrument can be operated as a free-running generator, or it can be synchronised with external signals.



The basic generating loop consists of the current sources, the ramp capacitor, the Schmitt trigger and the current switching circuit, as shown in Fig. 7.2



The upper current source supplies a constant current to the capacitor and the capacitor voltage increases linearly. When the positive slope of the ramp voltage reaches the upper limit set by the internal circuit components, the Schmitt trigger changes state. The trigger circuit output becomes negative and reverses the condition of the current switch. The capacitor discharges linearly, controlled by the lower current source. When the negative ramp reaches a predetermined 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, and is controlled by symmetry control. The sum of i_1 and i_2 determines the frequency. The size of the capacitor is selected by the multiplier switch.

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

b Explain the working of a square and pulse generator

The pulse should have minimum distortion, so that any distortion, in the display is solely due to the circuit under test.

1. The basic characteristics of the pulse are rise time, overshoot, ringing, sag, and undershoot.
2. The pulse should have sufficient maximum amplitude, if appreciable output power is required by the test circuit, e.g. for magnetic core At the same time, the attenuation range should be adequate to produce small amplitude pulses to prevent over driving of some test circuit.
3. The range of frequency control of the pulse repetition rate (PRR) should meet the needs of the experiment. For example, a repetition frequency of 100 MHz is required for testing fast circuits. Other generators have a pulse-burst feature which allows a train of pulses rather than a continuous
4. Some pulse generators can be triggered by an externally applied trigger signal; conversely, pulse generators can be used to produce trigger signals, when this output is passed through a differentiator circuit.
5. The output impedance of the pulse generator is another important In a fast pulse system, the generator should be matched to the cable and the cable to the test circuit.

A mismatch would cause energy to be reflected back to the generator by the test circuit, and this may be re-reflected by the generator, causing distortion of the pulses.

6. DC coupling of the output circuit is needed, when dc bias level is to be added.

8a) Explain the working of a sweep frequency generator.

It provides a sinusoidal output voltage whose frequency varies smoothly and continuously over an entire frequency band, usually at an audio rate. The process of frequency modulation may be accomplished electronically or mechanically.

It is done electronically by using the modulating voltage to vary the reactance of the oscillator tank circuit component, and mechanically by means of a motor driven capacitor, as provided for in a modern laboratory type signal generator. Figure 8.10 shows a basic block diagram of a sweep generator.

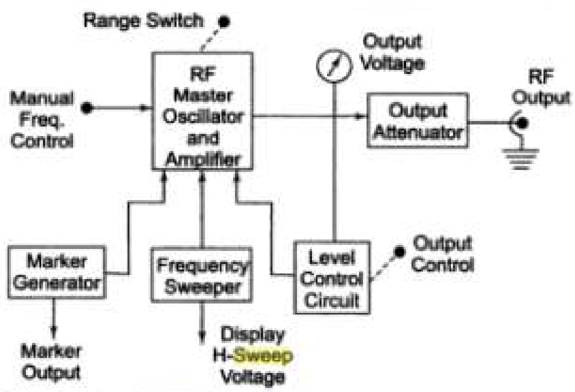


Fig. 8.10 Sweep Generator

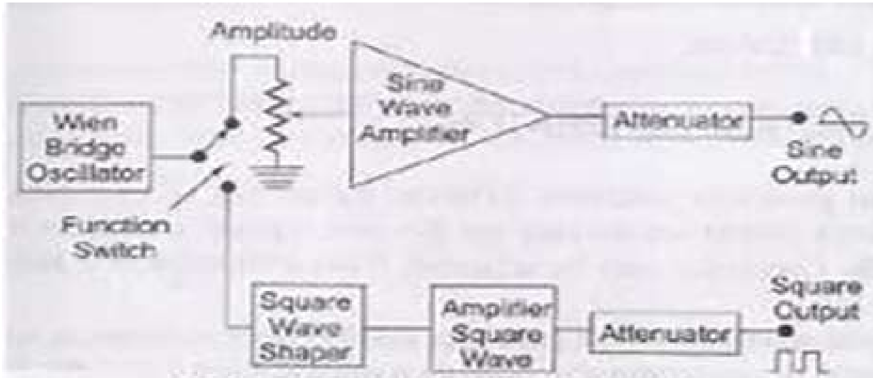
The frequency sweeper provides a variable modulating voltage which causes the capacitance of the master oscillator to vary. A representative sweep rate could be of the order of 20 sweeps/second. A manual control allows independent adjustment of the oscillator resonant frequency.

The frequency sweeper provides a varying sweep voltage for synchronisation to drive the horizontal deflection plates of the CRO. Thus the amplitude of the response of a test device will be locked and displayed on the screen.

To identify a frequency interval, a marker generator provides half sinusoidal waveforms at any frequency within the sweep range. The marker voltage can be added to the sweep voltage of the CRO during alternate cycles of the sweep voltage, and appears superimposed on the response curve.

The automatic level control circuit is a closed loop feedback system which monitors the RF level at some point in the measurement system. This circuit holds the power delivered to the load or test circuit constant and independent of frequency and impedance changes. A constant power level prevents any source mismatch and also provides a constant readout calibration with frequency.

b)Explain the working of an AF sine and square wave generator



AF Sine and Square Wave Generator

The signal generator is called an oscillator. A Wien bridge oscillator is used in this generator. The Wien bridge oscillator is the 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 the Wien bridge oscillator goes to the function switch. The function 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 from 10 Hz to 1 MHz, continuously variable in 5 decades with overlapping ranges. The output sine wave amplitude can be varied from 5 mV to 5 V (rms).The output is taken through a push-pull amplifier. For low output, the impedance is 600Ω. The square wave amplitudes can be varied from 0 — 20 V (peak). It is possible to adjust the symmetry of the square wave from 30 — 70%. The instrument requires only 7 W of power at 220 V — 50 Hz.

The front panel of a signal generator consists of the following.

1. Frequency selector It selects the frequency in different ranges and varies it continuously in a ratio of 1 : 11. The scale is non-linear.
2. Frequency multiplier It selects the frequency range over 5 decades, from 10 Hz to 1 MHz.
3. Amplitude multiplier It attenuates the sine wave in 3 decades, x 1, x 0.1 and x 0.01.
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 output continuously.
7. Function switch It selects either sine wave or square wave output.
8. Output available This provides sine wave or square wave output.
9. Sync This terminal is used to provide synchronisation of the internal signal with an external signal.
10. On-Off Switch