Que 1 A) *Attempt any **four*** ***20***

(a) *Explain the term synchronization and various sources of synchronization with reference to CRO.*
(b) *Draw and explain the block diagram of data logger. State its few areas of application.*
(c) *Explain the working principle of Eddy current type sensor with applications and advantages.*
(d) *Why a wave analyzer is called frequency selective voltmeter.*
(e) *Define the term Telemetry also draw and explain briefly the block diagram of Telemetry system employed in Instrumentation Systems.*

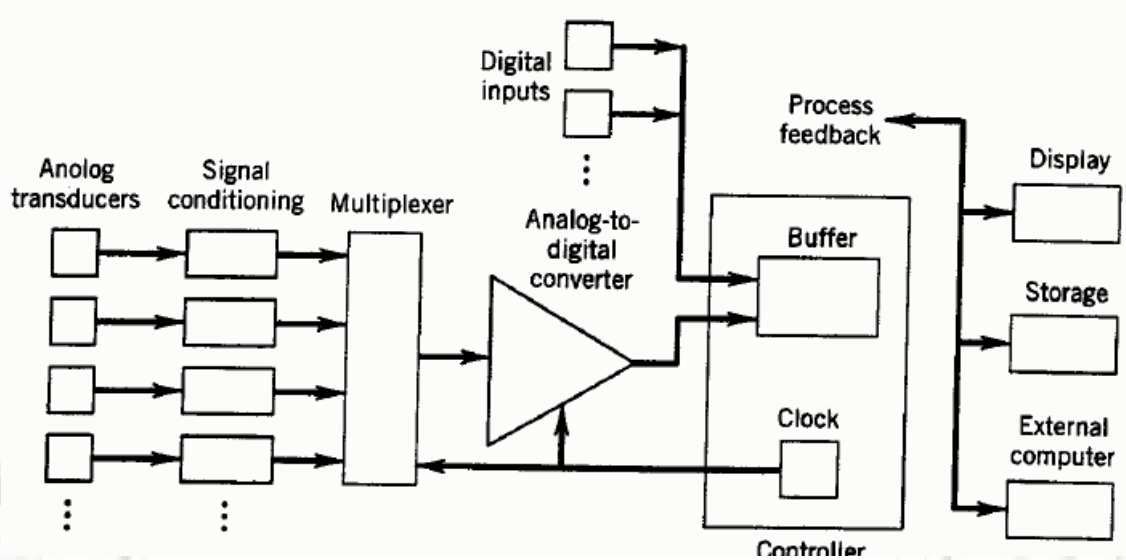
Ans:A) *sources of synchronization* :

trigger:Time base voltage must be synchronized with the input signal in the general case of a time-varying signal, such that a steady picture is obtained on the oscilloscope screen. Synchronization of the sweep waveform with the measured signal is most easily achieved by deriving the trigger signal from the measured signal, a procedure that is known as internal triggering. Alternatively, external triggering can be applied if the frequencies of the triggering signal and measured signals are related by an integer constant such that the display is stationary. External triggering is necessary when the amplitude of the measured signal is too small to drive the pulse generator, and it is also used in applications where there is a requirement to measure the phase difference between two sinusoidal signals of the same frequency. It is very convenient to use the 50 Hz line voltage for external triggering when measuring signals at mains frequency, and this is often given the name line triggering.

B) Data logger

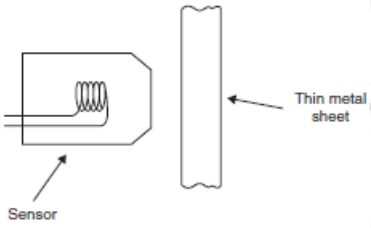
It is an application of DAS. Dedicated microprocessor systems can continuously perform their programming instructions to measure, store, interpret, and provide process control without any intervention. Such microprocessors have I/O ports to interface with other devices to measure and to output instructions. Programming allows for operations such as, which sensors to measure, and when and how often, and for data reduction. Programming can allow for decision-making and

feedback to control process variables.



1 C)Eddy current sensors

Eddy current sensors consist of a probe containing a coil, as shown in Figure below



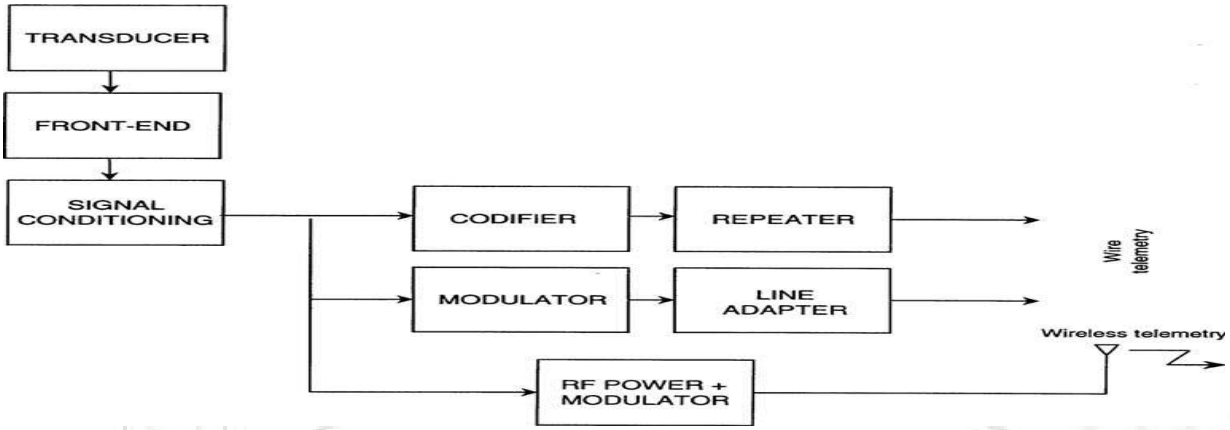
Eddy current sensor.

that is excited at a high frequency, which is typically 1MHz. This is used to measure the displacement of the probe relative to a moving metal target. Because of the high frequency of excitation, eddy currents are induced only in the surface of the target, and the current magnitude reduces to almost zero a short distance inside the target. This allows the sensor to work with very thin targets, such as the steel diaphragm of a pressure sensor. The eddy currents alter the inductance of the probe coil, andt his change can be translated into a d.c. voltage output that is proportional to the distance between the probe and the target. Measurement resolution as high as 0.1 □m can be achieved. The sensor can also work with a non-conductive target if a piece of aluminum tape is fastened to it.

D) wave analyzer are also called frequency selective voltmeter because instrument is tuned to frequency component whose amplitude is to be measured

E)Telemetry

Telemetry is the science of gathering information at some remote location and transmitting the data to a convenient location to be examined and recorded. Generalized block dia is shown below. It consists of (not all the blocks will be always present)



Transducers to convert physical variables to be measured into electric signals that can be easily processed; (2) Conditioning circuits to amplify the low-level signal from the transducer, limit its bandwidth, and adapt impedance levels; (3) a signal-processing circuit that sometimes can be integrated in the previous circuits; (4) a subcarrier oscillator whose signal will be modulated by the output of the different transducers once processed and adapted; (5) a codifier circuit, which can be a digital encoder, an analog modulator, or a digital modulator, that adapts the signal to the characteristics of the transmission channel, which is a wire or an antenna; (6)A radio transmitter, in wireless telemetry, modulated by the composite signal; (7) an impedance line adapter, in case of wire transmission, to adapt the characteristic impedance of the line to the output impedance of the circuits connected to the adapter; and (8) for wireless communication, a transmitting antenna

2 A) *What are Digital Transducers ? Explain Digital Transducer which uses optical* method for its operation with its advantages 10

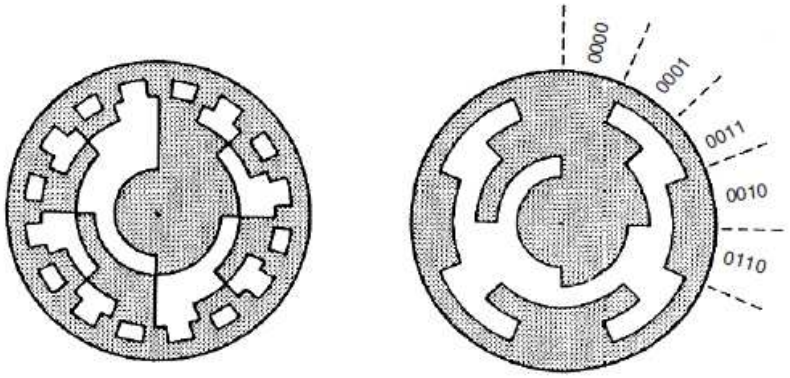
Ans:Digital transducer that gives a digital output in the form of pulses that has to be counted. The digital shaft encoder has an output in the form of a binary number of several digits that provides an absolute measurement of shaft position.

Advantages :Digital encoders provide high accuracy and reliability. They are particularly useful for computer control applications, but they have a significantly higher cost than incremental encoders. Three different forms exist, using optical, electrical and magnetic energy systems respectively

Contacting (electrical) digital shaft encoder

The contacting digital shaft encoder consists of only one disc that rotates with the body Whose displacement is being measured. The disc has conducting and non-conducting segments rather than the transparent and opaque areas found on the movable disc of the optical form of instrument, but these are arranged in an identical pattern of sectors and tracks. The disc is charged to a low potential by an electrical brush in contact with one side of the disc, and a set of brushes on the other side of the disc measures the potential in each track. The output of each detector brush is interpreted as a binary

value of '1' or '0' according to whether the track in that particular segment is conducting or not and hence whether a voltage is sensed or not. As for the case of the



Binary code with anti-ambiguity track

Gray code

optical **20.7** Modified window arrangements for the rotating disc.

form of instrument, these outputs are combined together to give a multi-bit binarynumber. Contacting digital shaft encoders have a similar cost to the equivalent optical instruments and have operational advantages in severe environmental conditions of high temperature or mechanical shock. They suffer from the usual problem of output ambiguity at the sector boundaries but this problem is overcome by the same methods as used in optical instruments. A serious problem in the application of contacting digital shaft encoders arises from their use of brushes. These introduce friction into the measurement system, and the combination of dirt and brush wear causes contact problems. Consequently, problems of intermittent output can occur, and such instruments generally have limited reliability and a high maintenance cost. Measurement resolution is also limited because of the lower limit on the minimum physical size of the contact brushes. The maximum number of tracks possible is ten, which limits the resolution to 1 part in 1000. Thus, contacting digital shaft encoders are only used where the environmental conditions are too severe for optical instruments

Que 2 B*) A 4-bit R-2R Ladder network type Digital to Analog Converter has input 1010 and reference voltage 10 V. Find its output voltage and conversion resolution.* 6

Ans:

$V_o = -V_R \sum_{i=1}^{N} \frac{b_i}{2^i}$; where b_1 is MSB

Output for 1010 is =10/2+10/8=5+1.25=6.25

$\text{Resolution} = \frac{V_R}{2^N}$; where N is number of bits

Hence resolution is 10/16=0.625

Que 2 C) *Explain various factors which govern intensity of phosphor screen on CRO*

Ans: Phosphor screen intensity :

The phosphor functions as the CRT transducer. It converts the energy of the electron beam into light. This conversion process is called cathode luminescence. CRT phosphors are inorganic crystalline materials doped with one or more impurities called activators and co activators. Phosphors emit light in two ways, fluorescence and phosphorescence. Fluorescence is the emission of light by the

phosphor material while it is under bombardment by the electron beam. The continued emission of light after the bombardment has ceased is called phosphorescence. The length of time phosphorescence lasts is known as persistence. Persistence can vary from tens of nanoseconds to many minutes, or even hours. CRTs take advantage of both forms of cathode luminescence. Briefly, cathode luminescence occurs when the electron beam excites the electrons of the phosphor into higher, unstable energy states available due to the presence of the activators. When the electrons transition back to their stable states, light is emitted. The choice of phosphor depends on the requirements of the application with respect to wavelength characteristics i.e.narrow emission spectra or broadband emission, color, brightness, resolution, and persistence. Commercial television CRTs typically make use of the following phosphor powders:

P7 colour :blue white persistence: medium short

P11 colour :blue violet persistence: medium short

P15 colour :blue green persistence :visible short

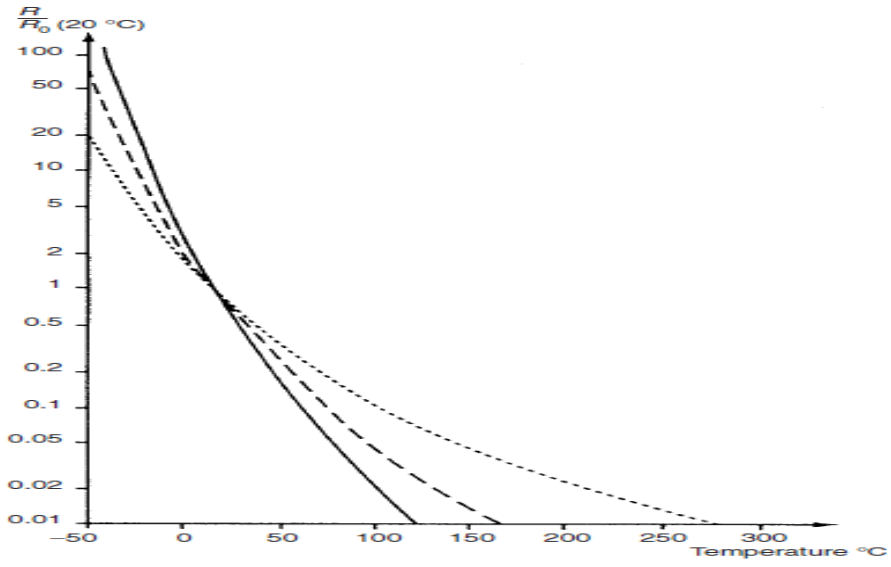
Television CRTs use moderately short persistence phosphors. This ensures a new frame does not exhibit blurring due to the previous frame. Traditionally, phosphors for radar displays, where the screen is refreshed infrequently, had a mix of short and long persistence. However, with the advent of today's digital systems, the use of long-persistence phosphors has declined.

3 A) *Describe in detail Thermistor for its working principle, Resistance-Temperature* *10*

Ans: Thermistors:Thermistors are manufactured from beads of semiconductor material prepared fromoxides of the iron group of metals such as chromium, cobalt, iron, manganese andnickel. Normally, thermistors have a negative temperature coefficient, i.e. the resistance decreases as the temperature increases, according to:

$$R = R_0 e^{[\beta(1/T - 1/T_0)]}$$

This relationship is illustrated in Figure.



However, alternative forms of heavily doped thermostats are now available (at greater cost) that have a positive temperature coefficient. The form of above equation is such that it is not possible to make a linear approximation to the curve over even a small temperature range, and hence the thermistor is very definitely a non-linear sensor.

Advantages

thermistors are their relatively low cost and their small size. This size advantage means that the time constant of thermistors operated in sheaths is small, although the size reduction also decreases its heat dissipation capability and so makes the self heatingeffect greater. In consequence, thermistors have to be operated at generally lower current levels than resistance thermometers and so the measurement sensitivityis less

Que 3 B) *Self capacitance and the inductance of the coil is to be measured using series connection in Q-meter. First measurement is at frequency 2 MHz and tuning capacitor value is 460 pf. The frequency is 4 MHz and tunning capacitor valueis 100 pf for second measurement. Calculate the value of self capacitance of a coil and inductance* 6M

Cd=(C1-4*C2)/3

=(460-4*100)/3 = 20 pF

QUE 3 C*) Explain the Capacitive Transducer based on differential arrangement for its working principle and advantages over other arrangements.* 4

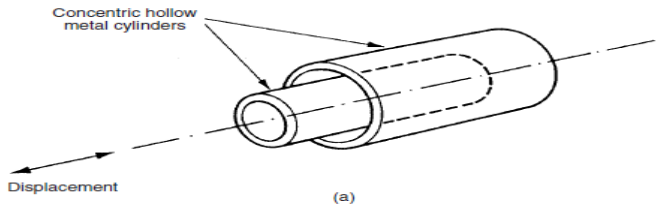
Ans :Capacitive transducer employ the principal of change in capacitance.

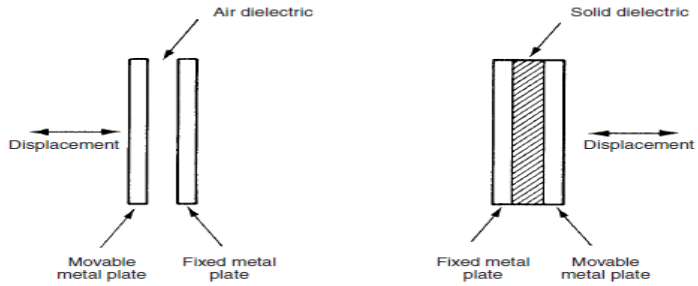
The capacitance C is dependent on the dielectric medium and the properties of the system.

The capacitance of the capacitor is given by C=KA/D

Where K – dielectric constant A – Total area of capacitor D – distance between two parallel plates.

Capacitance increases when effective area and dielectric constant increases and decreases if distance between two parallel plates is increased





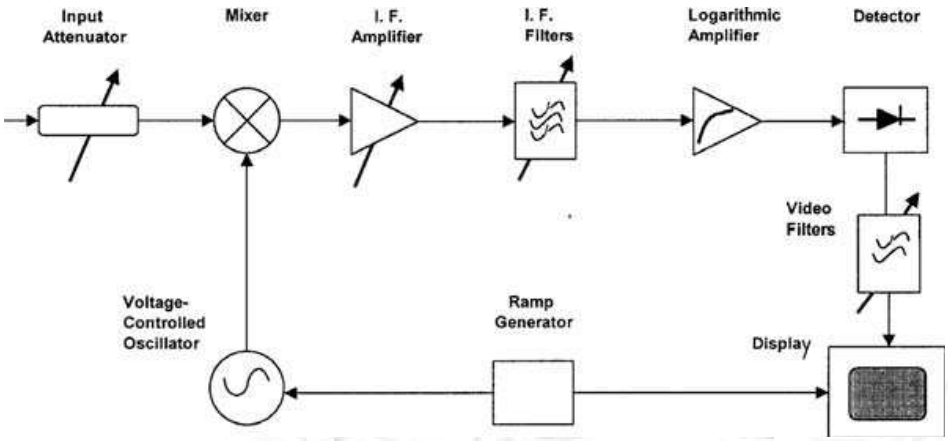
In the first arrangement the displacement to be measured is applied to the inner cylinder, which alters the capacitance. The second form, Figure 19.3(b), consists of two flat, parallel, metal plates, one of which is fixed and one of which is movable. Displacements to be measured are applied to the movable plate, and the capacitance changes as this moves. Both of these first two forms use air as the dielectric medium between the plates. The final form, Figure (c), has two flat, parallel, metal plates with a sheet of solid dielectric material between them. The displacement to be measured causes a capacitance change by moving the dielectric sheet.

QUE 4 A) Describe in detail the working principle of swept superheterodyne type Spectrum Analyzer with block diagram

ANS:The major application of the spectrum analyzer is to study the radio frequency spectrum produced in the microwave instruments.

The signals are separated by only a few KHz in the microwave frequency range. These signals can be individually studied by using the spectrum analyzer.

The frequency range covered by this instrument is from 500KHz to 1 GHz



Working :

The output of sawtooth generator is applied to the voltage tuned oscillator and the horizontal deflection plates of the CRO.

The voltage tuned oscillator produces the frequency from 2 GHz to 3 GHz

An input signal is applied to the low pass filter. The range of input single is from 0 to 1 GHz. This signal is mixed with the output of the voltage tuned oscillator.

The mixer consists of two signals that are proportional in amplitude to the input signal.

The frequencies of these signals are proportional to the sum and difference of input signal and local oscillator frequency.

The output signal form the mixer is applied to the if amplifier. This if amplifier is tuned to a narrow band about 2 GHz.

The frequency of the voltage tuned local oscillator is 2 to 3 GHz. The input signals which are separated from voltage tuned local oscillator by 2 GHz will be only converted to the if frequency band.

This output from if amplifier is applied to the detector and then to the vertical deflecting plates of the CRO. This gives a plot of amplitude versus frequency components on the CRO.

Applications :

Measurement of harmonic distortion :

Pulse modulation :

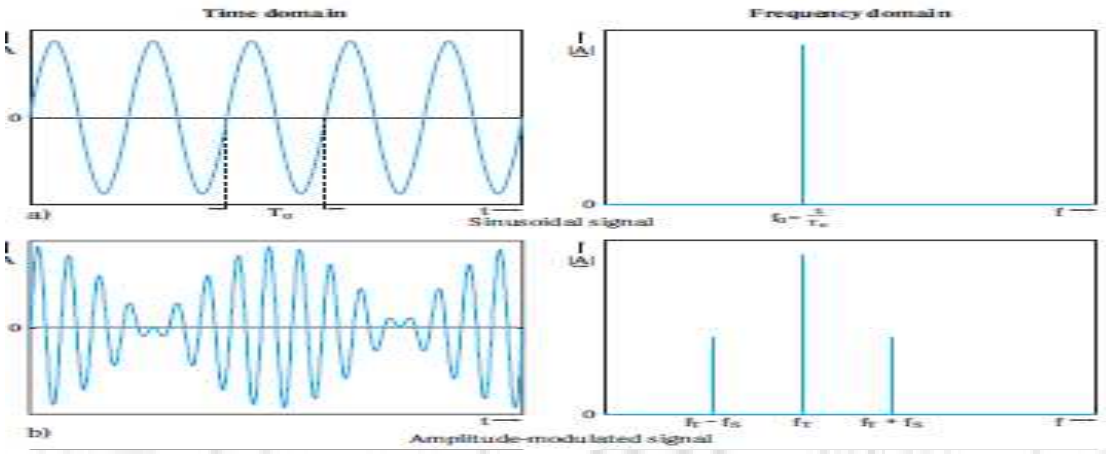
Noise measurement :

Continuous wave signal

frequency stability :

Que 4b) Sketch and explain the display using swept Superheterodyne Spectrum Analyzer for following signals :— 6

(i) A pure sine wave with frequency half way between the two extremes of the swept frequency range. (ii) An Amplitude Modulated sine waveform. (iii) A sine wave with a small amount of harmonic distortion



Q4 c) *Explain in detail Roll Mode operation of Digital Storage Oscilloscope*

This Roll mode is used for for observing fast varying signal..

In this mode input signal is not trigged at all so the fast changing signal is displayed on screen as if it is changing slowly

The stored signal is rolled across the screen from right to left.

Q 5 A)) Explain in detail weighted resistor Digital to Analog Conversion Technique with its advantages and disadvantages over other types of Digital to Analog Converters N-Bit Binary Weighted DAC 10

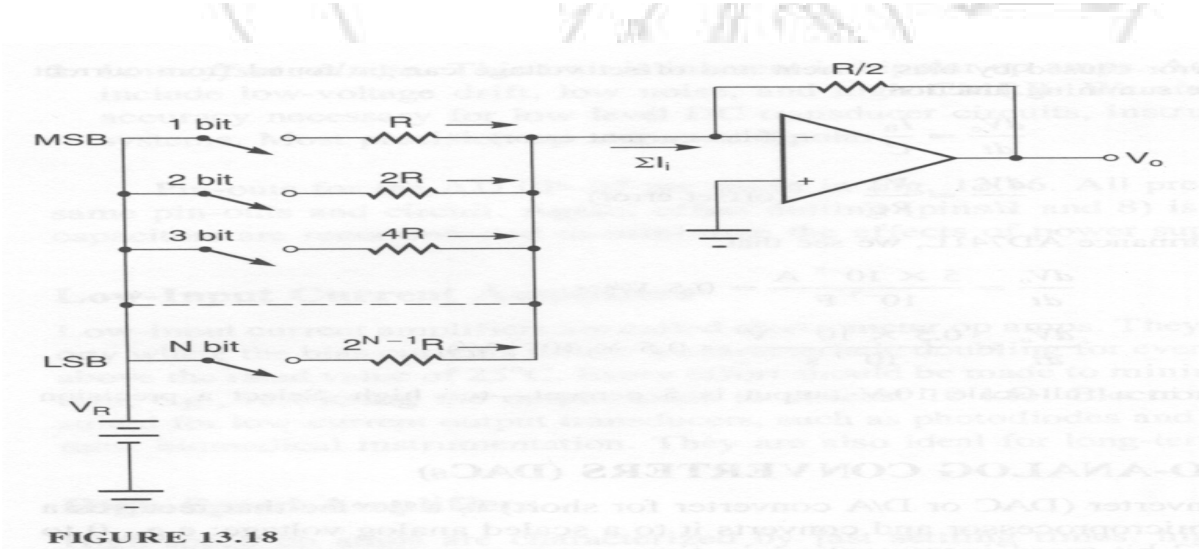


FIGURE 13.18
Binary weighted ladder DAC.

Binary Weighted Principles

$$I_0 = V_R \sum_{i=1}^{N} \frac{b_i}{2^{(i-1)} R}$$

I_0 = sum of currents leaving junction

R = resistance corresponding to MSB

N = number of input bits

b_1 = MSB

V0 = -RfI0

V0 = voltage output from amplifier

Rf = feedback resistance

Resolution= VR/2N

Note: For a gain of 1, R = 2Rf

Limitation

Op-amps to handle high currents are expensive because this is usually below the current noise threshold

The resistance values must be accurate to less than one part in 2N for the RN input to be

meaningful. This is difficult to do, especially in IC's.

QUE 5 B) *Explain in detail ALT and CHOP mode of operation of CRO.* *6*

ANS:Alternate Mode :-

In the "alternate mode" the electronic switch connects the two channels A and B alternately in the successive cycles of the sweep generator. When the time base is set at slow speed the alternate mode operation can be easily seen.

The electronic switch connects the channel A and channel B to the vertical amplifier. The switch is controlled by a toggle fliplop. Initially we set the position of channel A to upper half of the screen position of channel B to the lower half of the screen, such that the two waveforms are separately scan.

Chop Mode :-

In the "chop" mode the electronic switch will make several transitions from one channel to the other channel during one sweep.A free running oscillator is used to control the position of the electronic switch. So, channel A is displayed for a very short time, the channel B and then again channel A.

This contioues at a very fast rate. Due to such a high switching rate, the displayed signals appear to be stable. Typically, the switching rate of electronic switch is between 100KHz and 500KHz

If the switching rate is slow, then the continuity of display is lost. In such cases alternate mode is preferred.

Que 5 c) *Define and relate sampling rate and Bandwidth specifications of DSO.* *4*
Usb= max. Digitalizing rate /const C

Where c depend on interpolation method for dot display ,straight line interpoalation cis 25 and 2.5 respectively

Que 6 A) *What is time base selector in Digital Frequency meter ? Draw and explain its block diagram and state its importance in the measurements done using Digital Frequency meter* *10*

Time base generator

It is clear that in order to know the value of frequency of the input signal, the time interval between the start and stop of the gate must be accurately known. This is called time base. The time base consist of a fixed frequency Crystal oscillator, called a clock oscillator, which has to be very accurate. In order to ensure its accuracy, the crystal is enclosed in a constant temperature oven. The output of this constant frequency oscillator is fed to a Schmitt trigger, which converts the input sine wave to an output consisting of a train of pulses at a rate equal to the frequency of the clock oscillator. The train of pulses then passes through a series of frequency divider decade assemblies connected in cascade. Each decade divider consists of a decade counter and divides the frequency by ten. Outputs are taken from each decade frequency divider by means of a selector switch; any output may be selected. The circuit of Fig.

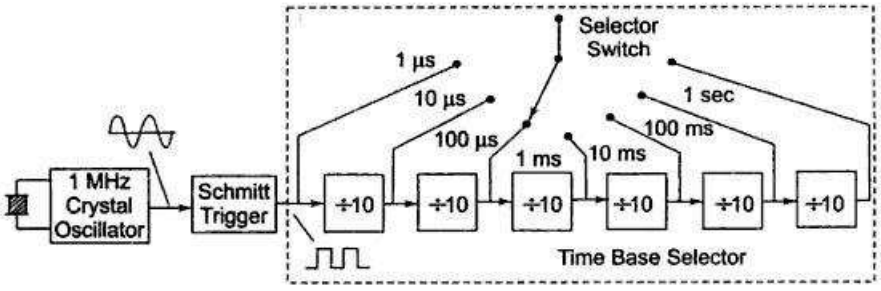


Fig. 6.8 Time Base Selector

consists of a clock oscillator having a 1 MHz frequency. The output of the Schmitt trigger is 106 pulses per second and this point corresponds to a time of 1 microsecond. Hence by using a 6 decade frequency divider, a time base with a range of 1 micros 10 micro s — 100 micros — 1 ms 10 ms — 100 ms —1 s can be selected using a selector switch.

QUE 6 B) *Gating period of 1 msec, 10 msec, 100 msec, 1 sec, 10 sec are provided on a digital counter-timer-frequency meter having 3 digit display. A gating period of 10 msec is selected to measure an unknown frequency and a reading of 034 is obtained.* 6

(i) What is the likely value of frequency of an unknown signal ?

(ii) To obtain a move accurate measurement of frequency of an unknown signal, what will you do and why ? Justify.

a) f = N/t = 034/10 ms = 3.4 kHz

b) for better resolution higher getting time is required for example suppose frequency is 3420 the reading will be

3420*1000ms=342

If gating period is 1 s the reading will be

3424*1=3424

This implies meter overflow

same applies to 10ns

6 c) *Calculate the gauge factor (G) if 1 -5 mm diameter conductor that is 24 mm long changes length by 1 mm and diameter by 0.02 mm under a compression force.* 4

ANS: $GF = \frac{\frac{\Delta D}{D}}{\frac{\Delta L}{L}}$

=(0.02/1.5)/(1/24) = 0.01333/0.04166 = 0.31

Q7 A) *Write short notes on (any **three**) :—* 20

(a) General specifications of Digital Voltmeter
(b) Automation in Digital Instruments
(c) Velocity Modulation with reference to CRO
(d) Universal Counter.

a) General specification of digital voltmeter

Quoted inaccuracy : are between +/- 0.005% (measuring d.c. voltages) and +/2%.

High Input impedance (10M_ compared with 1–20 k_ for analogue meters),

the ability to measure signals of frequency upto 1MHz and

The common inclusion of features such as automatic ranging, which prevents overload and reverse polarity connection etc.

Output displays: Four-, five- or even six-figure

Q 7 c) Velocity modulation :Application of potentials to two sets of deflector plates mounted at right angles to one another within the tube provide for deflection of the stream of electrons, such that the spot where the electrons are focused on the screen is moved. The two sets of deflector plates are normally known as the horizontal and vertical deflection plates, according to the respective motion caused to the spot on the screen. This is called velocity modulation .The magnitude of any signal applied to the deflector plates can be calculated by measuring the deflection of the spot against a crossed-wire gratitude etched on the screen