Wave Analyzers

Concept of Wave Analyzers

Complex waveform is made up of a fundamental and its harmonics.

Wave analyzers: Instrument to measure the amplitude of each harmonic or fundamental individually.

Wave analyzers are also referred to as frequency selective voltmeters, carrier frequency voltmeters, and selective level voltmeters.

The instrument is tuned to the frequency of one component whose amplitude is measured.

This instrument is a narrow band superheterodyne receiver.

Distortion

When a sinusoidal signal is applied to the input of an ideal linear amplifier, it produces a sinusoidal output waveform. However, in most cases the output waveform is not an exact replica of the input signal because of different types of distortion.

The amount by which the output waveform of an amplifier differs from the input waveform is a measure of the distortion introduced by the inherent non-linear characteristics of the active devices.

Harmonic Distortion Analyzers

Harmonic distortion analyzers measure the total harmonic content in the waveforms.

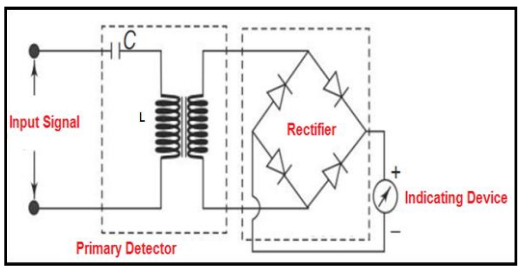
It can be shown mathematically that an amplitude distorted sine wave is made up of pure sine wave components, including the fundamental frequency *f of the input signal, and harmonic multiples of the fundamental frequency, 2f, 3f, 4fetc.*

The total harmonic distortion or factor is given by $D = \sqrt{D_2^2 + D_3^2 + D_4^2 \cdots}$

where *D2, D3, D4 ... represent the second harmonic, third harmonic, etc.* respectively.

The distortion analyzer measures the total harmonic distortion without indicating the amplitude and frequency of each component waves.

BASIC WAVE ANALYZER



•Consists of a primary detector with a simple LC circuit.

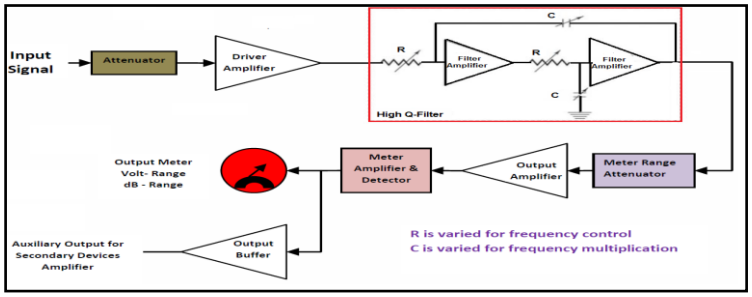
•LC circuit is adjusted at resonance frequency for the particular harmonic component to be measured.

•LC circuit is tuned to a single frequency and passes only the frequency to which it is tuned and rejects all other frequencies.

•Full wave rectifier (intermediate stage): Obtain the average value of the input signal.

•DC voltmeter (indicating device): Calibrated to read the peak value of the sinusoidal input voltage.

FREQUENCY SELECTIVE WAVE ANALYZER



- Wave analyzer is a very narrow pass-band filter section which is tuned to a particular frequency within the audible frequency range (20 Hz - 20kHz).
- The complex wave to be analyzed is passed through an adjustable attenuator which serves as a range multiplier and permits a large range of signal amplitudes to be analyzed without loading the amplifier.
- The driver amplifier amplifies the selected frequency and then applies to a **high-Q active filter** (low pass filter which allows the frequency which is selected to pass and reject all others).
- Magnitude of this selected frequency is indicated by the meter and the filter section identifies the frequency of the component.
- The filter circuit consists of a cascaded RC resonant circuit and amplifiers.
- The capacitors are used for range changing and the potentiometer is used to change the frequency within the selected pass-band, Hence this wave analyzer is also called a Frequency selective voltmeter. (The entire AF range is covered in decade steps by switching capacitors in the RC section).
- The selected signal output from the final amplifier stage is applied to the meter circuit and to an untuned buffer amplifier.
- The main function of the buffer amplifier is to drive output devices, such as recorders or electronics counters.
- The meter has several voltage ranges as well as decibel scales marked on it. It is driven by an average reading rectifier type detector.

Heterodyne Wave Analyzers

Wave analyzers are useful for measurement in the audio frequency range only.

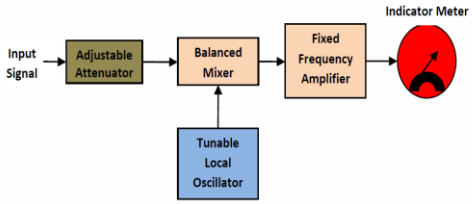
For measurements in the RF range and above (MHz range), an ordinary wave analyzer cannot be used. Hence, special types of wave analyzers working on the principle of heterodyning (mixing) are used. These wave analyzers are known as Heterodyne wave analyzers.

In this wave analyzer, the input signal to be analyzed is heterodyned with the signal from the internal tunable local oscillator in the mixer stage to produce a higher IF frequency.

By tuning the local oscillator frequency, various signal frequency components can be shifted within the pass-band of the IF amplifier.

The output of the IF amplifier is rectified and applied to the meter circuit.

Heterodyne Wave Analyzers



•The input signal is heterodyned to the known IF by means of a tunable local oscillator.

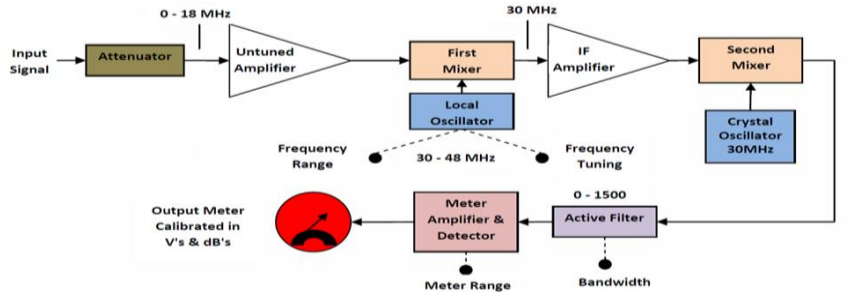
•The amplitude of the unknown component is indicated by the output meter.

•The output meter is calibrated by means of signals of known amplitude.

•The frequency of the component is identified by the local oscillator frequency, i.e. the local oscillator frequency is varied so that all the components can be identified.

•The local oscillator can also be calibrated using input signals of known frequency.

RF Heterodyne Wave Analyzers



- The attenuator provides the required input signal for heterodyning in the first mixer stage, with the signal from a local oscillator having a frequency of 30 - 48MHz.
- The first mixer stage produces an output which is the difference of the local oscillator frequency and the input signal, to produce an IF signal of 30 MHz.
- This IF frequency is uniformly amplified by the IF amplifier which is fed to the second mixer stage, where it is again heterodyned to produce a IF of zero frequency.
- The selected component is then passed to the meter amplifier and detector circuit through an active filter having a controlled band-width.
- The meter detector output can then be read off on a db-calibrated scale, or may be applied to a secondary device such as a recorder.
- This wave analyzer is operated in the RF range of 10kHz - 18 MHz.