2.6 MEASUREMENT OF VSWR AND WAVELENGTH

(A) Measurement of Voltage Standing Wava Ratio (VAWR)

If V_{max} and V_{min} are known, then SWR can be calculated by using the following equation:

SWR = $\frac{|V_{max}|}{|V_{min}|}$

Therefore the determination of SWR in fact, is the determination of V_{max} and V_{min} .

(i) Open Wire Line:

The value of V_{max} and V_{min} can be readily obtained on open wire line by arranging a simple set up as shown in the following Fig 2.6.1.

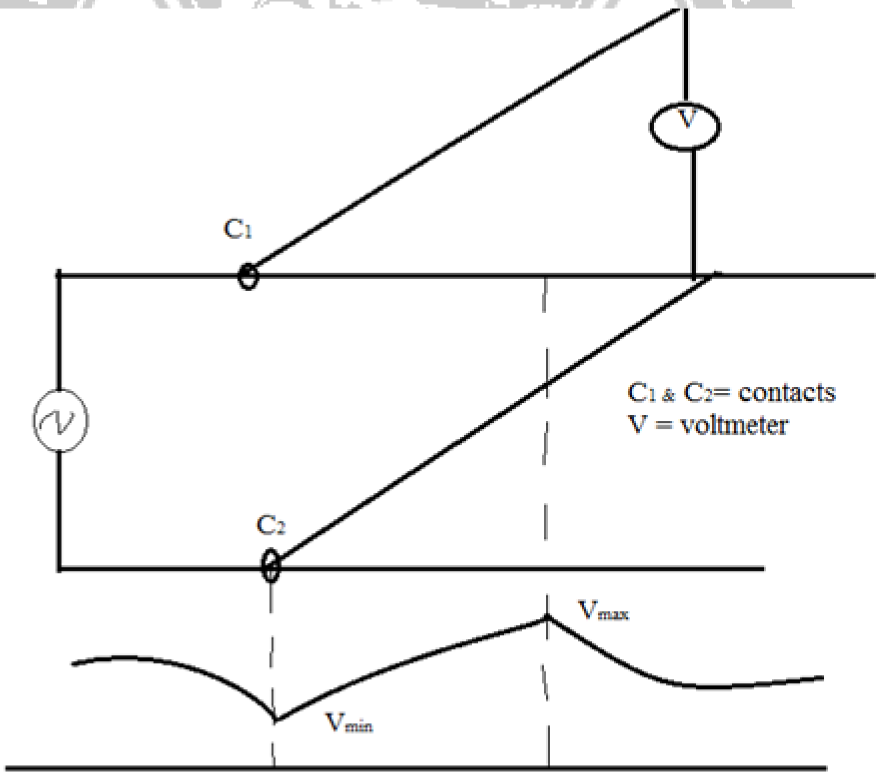

Fig: 2.6.1 Determination of SWR on open wire line

A sliding contact A.C(r.m.s) voltmeter V is used to measure the voltage at different points along the line by sliding contact C_1 and C_2. One thing that becomes obvious is that the ratio of Vmax to Vmin becomes larger as the reflection coefficient increases. That is, if the ratio of Vmax to Vmin is one, then there are no standing waves, and the impedance of the line is perfectly matched to the load. If the ratio of Vmax to Vmin is infinite, then the magnitude of the reflection coefficient is 1, so that all power is reflected. Hence, this ratio, known as the Voltage Standing Wave Ratio (VSWR) or standing wave ratio is a measure of how well matched a transmission line is to a load.

(ii) Coaxial Cable:

The VSWR measuring setup for a coaxial line is shown in the following Fig 2.6.2. For coaxial lines, It is necessary to use a length of line in which a longitudinal slot, one half wavelength or more long has been cut.

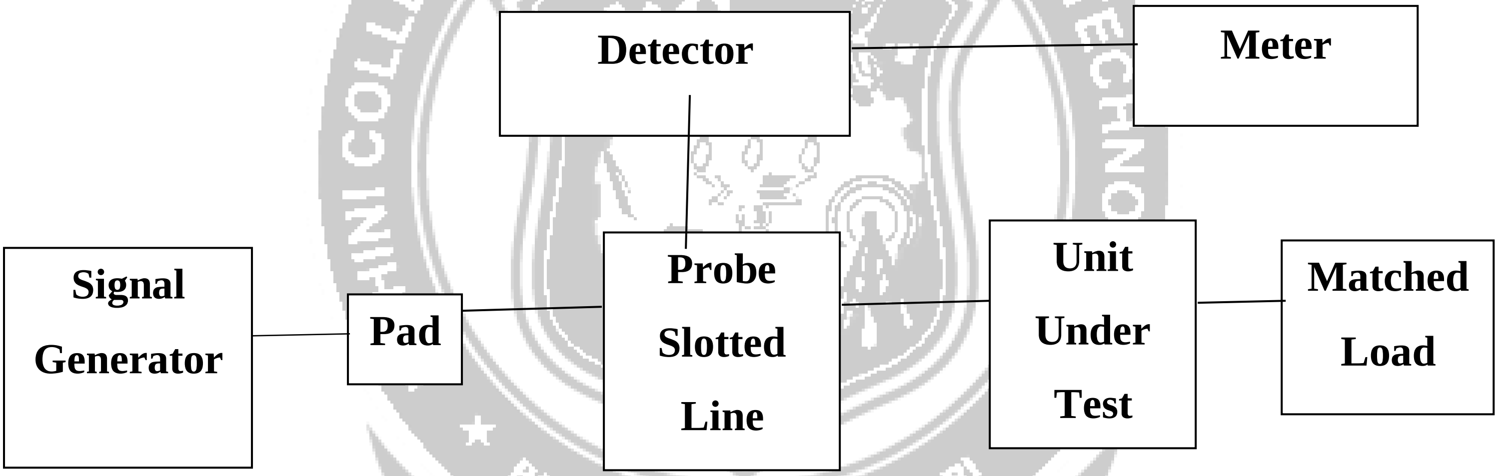

Fig: 2.6.2 Determination of SWR for coaxial cable

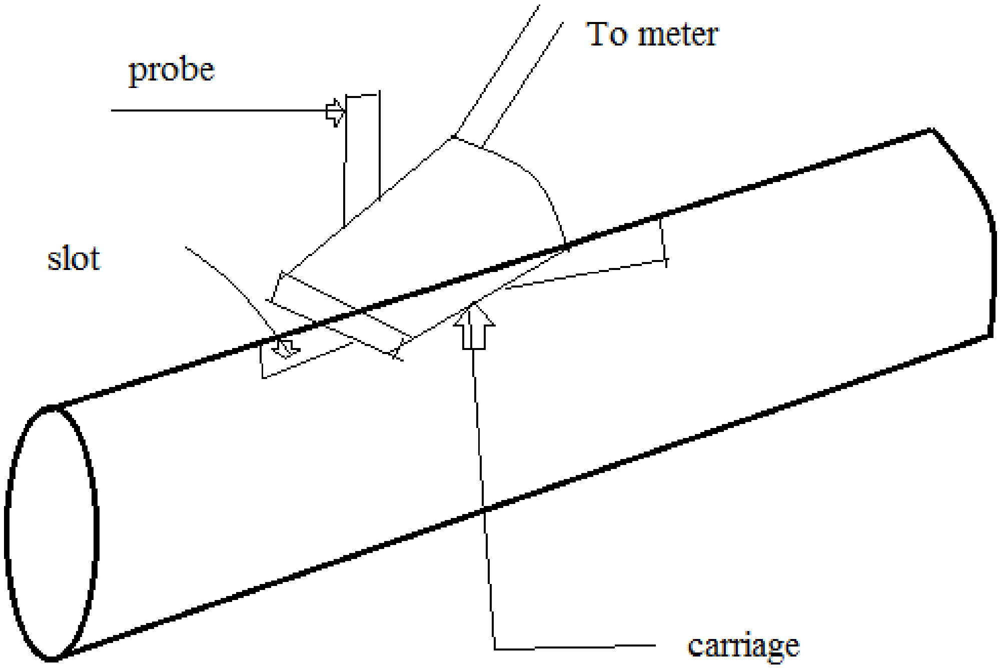

Fig: 2.6.3 Diagram of a slotted line section and a probe voltmeter for SWR measurement

The signal source must present a matched impedance looking back into it otherwise, reflections from the network being tested will reflect again off the signal generator and cause the peaks and nodes to shift in proportion in the standing wave pattern. The Fig 2.6.3 shows that the diagram of a slotted line section and a probe voltmeter for SWR measurement

(iii) <u>Directional Couplers:</u>

For direct indication and measurement of standing waves a device known as directional coupler can be used in the following Fig 2.6.4.

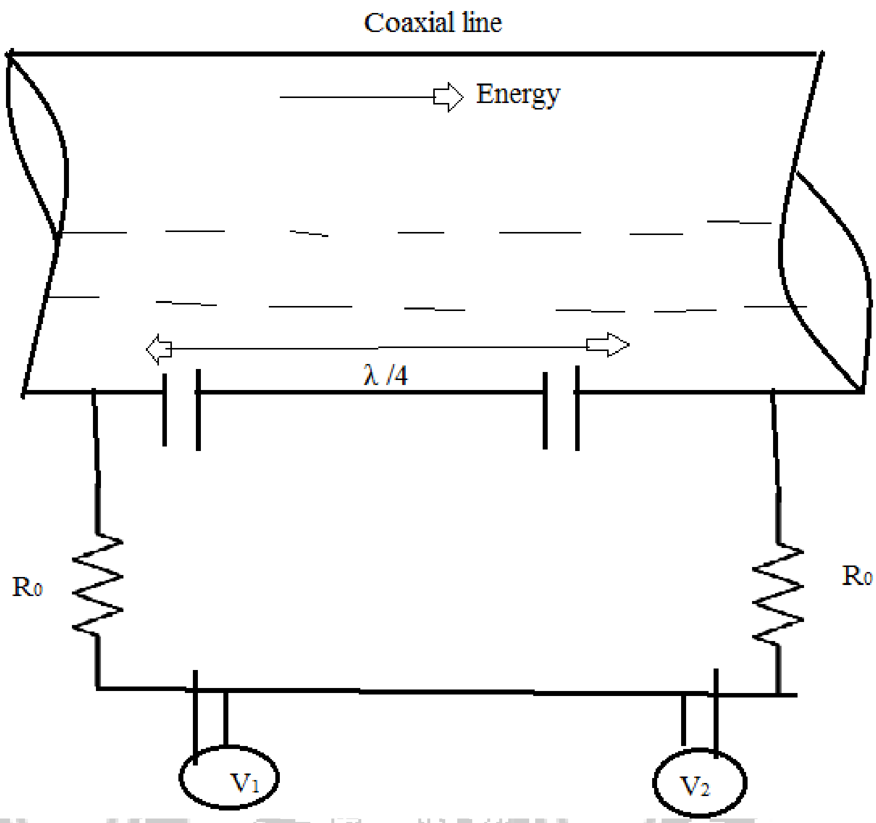

Fig: 2.6.4 A directional coupler on a coaxial line

(iv) The Reflectometers

In this, advantage is taken of the fact that the voltage on transmission line consists of two components travelling in opposite directions. The power goin from the transmitter to the load is represented by incident wave and the power reflected from the load is represented as reflected voltage.

If $R_1 = R_2$, the bridge of Fig 2.6.5 will be balanced when $R_x = R_S$. This is true is the input resistance of a perfectly matched transmission line and R_S is chosen equal to the characteristic impedance Zo of the line.

The SWR cab be calculated from the following formula:

$$SER = \frac{V_i + V_r}{V_i - V_r}$$

V_i = incident voltage

V_r = reflected voltage

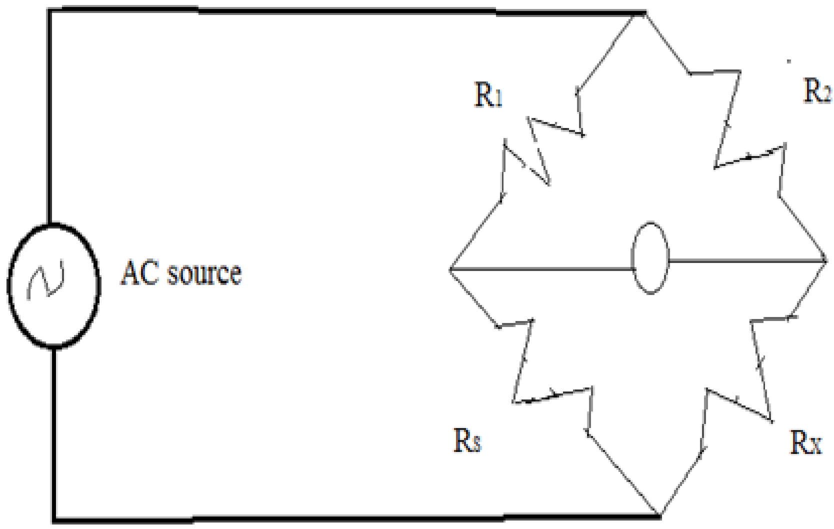

Fig: 2.6.5 SWR measurements by reflectometer

(B) Measurement of Wavelength (λ):

It is based on the fact that the distance between two successive voltage / current maxima or minima being equal to half wavelength $\frac{\lambda}{2}$. Such measurements when made on open wire line is called lecher measurements.

(i) Resonant air insulated lines are normally used to measure wavelength. The line is arranged with a movable short circuit at one end is loosely coupled to the generator at the other, when the line is adjusted to a resonant length, the energy coupled from the generator is able to built-up an oscillation of large amplitude of the line.

A parallel-wire line P used for this purpose is called Lecher-wire system and shown in Fig 2.6.6. Resonance is determined by the reading of a current indicator connected in the short circuiting slider S.

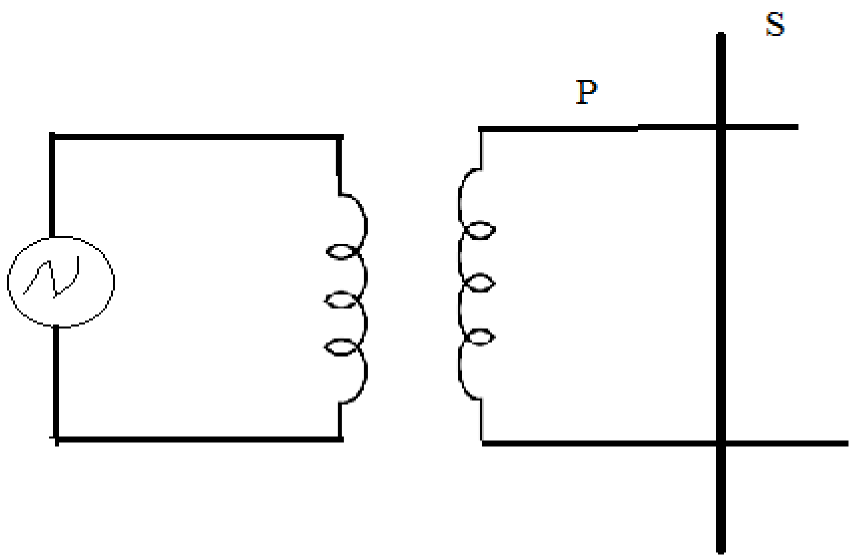

Fig: 2.6.6 Measurements of λ with Lecher-wire system

(ii) At short wavelengths, the preceding method is used with a coaxial cable and an instrument built especially for this purpose is called coaxial wavemeter. It consists of an air insulated coaxial line which is closed at one end and has a movable short at the other. When the coaxial meter has been adjusted to one of these lengths, the current in the coupling loop is able to built up an oscillation of large amplitude within the wavemeter.