

Modulation

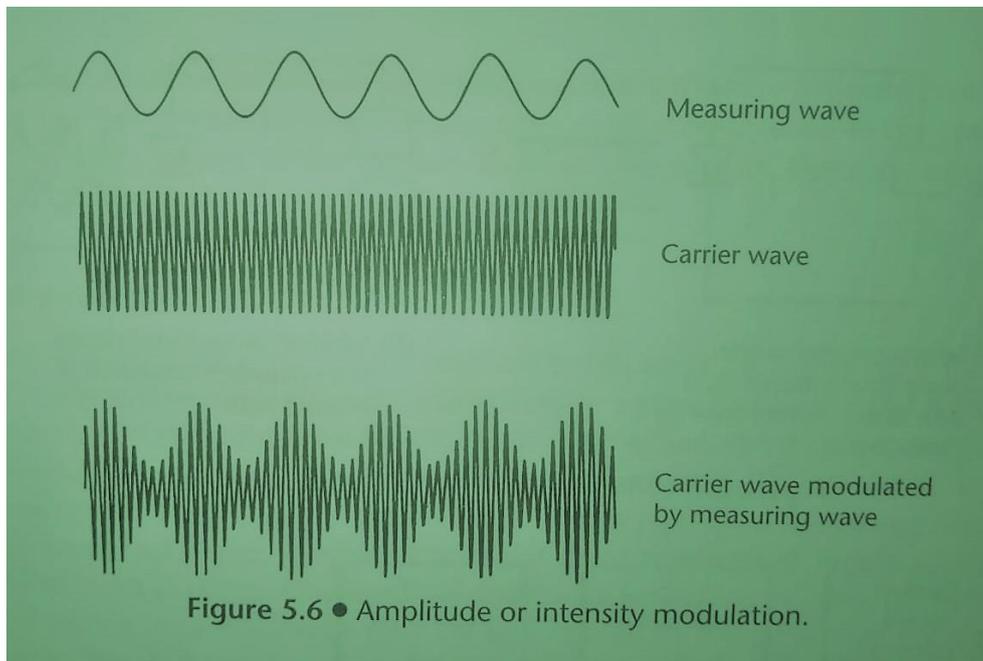
Total stations use the wavelength 2m of an electromagnetic wave as the basic unit for measuring a distance by the phase measurement method. The value chosen for λ_m depends to a great extent on the desired accuracy of the instrument and on *phase resolution*, the smallest fraction of a cycle that the instrument is capable of resolving. By combining a distance resolution of 1 mm with $1/10,000$ digital phase resolution, a typical value chosen for λ_m is 10 m ($1\text{ mm} \times 10,000$), which corresponds to a frequency for the measuring wave of 30 MHz .

This and similar frequencies used for distance measurement by total stations are in the VHF part of the electromagnetic spectrum and, although it is possible to generate and transmit a VHF signal fairly easily, problems occur when these are to be propagated through the atmosphere. To transmit this order of frequency over any distance without significant attenuation of the signal would require either a very large transmitter or a small but very inefficient transmitter that would require considerable power to drive it.

Both of these alternatives are unacceptable for portable surveying equipment. A solution to these problems might be to decrease the value of 2m and therefore increase the frequency of measurement and accuracy of length measurement.

This could be done until a suitable compromise is reached for both transmission and measurement. Unfortunately, the phase measurement process tends to become unstable at high frequencies, and use of a very short

measuring wavelength would result in difficulties with resolving the ambiguity of measurement.



In order to be able to use a typical measuring wavelength of 10 m and combine this with efficient propagation, the process of *modulation* is used, in which the measuring wave is mixed with a *carrier wave* of much higher frequency. The carrier wave **is** chosen to be a type of radiation that can be transmitted through the atmosphere without serious attenuation over long distances.

The type **of** modulation used in the majority of total stations is *amplitude or intensity modulation* (Figure 5.6), **in** which the measuring wave is used to vary the amplitude of the carrier wave. During a

distance measurement, although it is the carrier wave that is transmitted, the phase measurement is carried out as if the measuring wave was transmitted directly.

The carrier waves used in most instruments are either infrared or visible red lasers and **this** is due to the carrier source, which is a semiconductor diode. These can be very easily amplitude modulated at the high frequencies required for distance measurement and provide a simple and inexpensive method of producing a modulated carrier wave.