LASCELLS®

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MICROWAVE TRANSMITTER RECEIVER

LA50-420
LA50-430

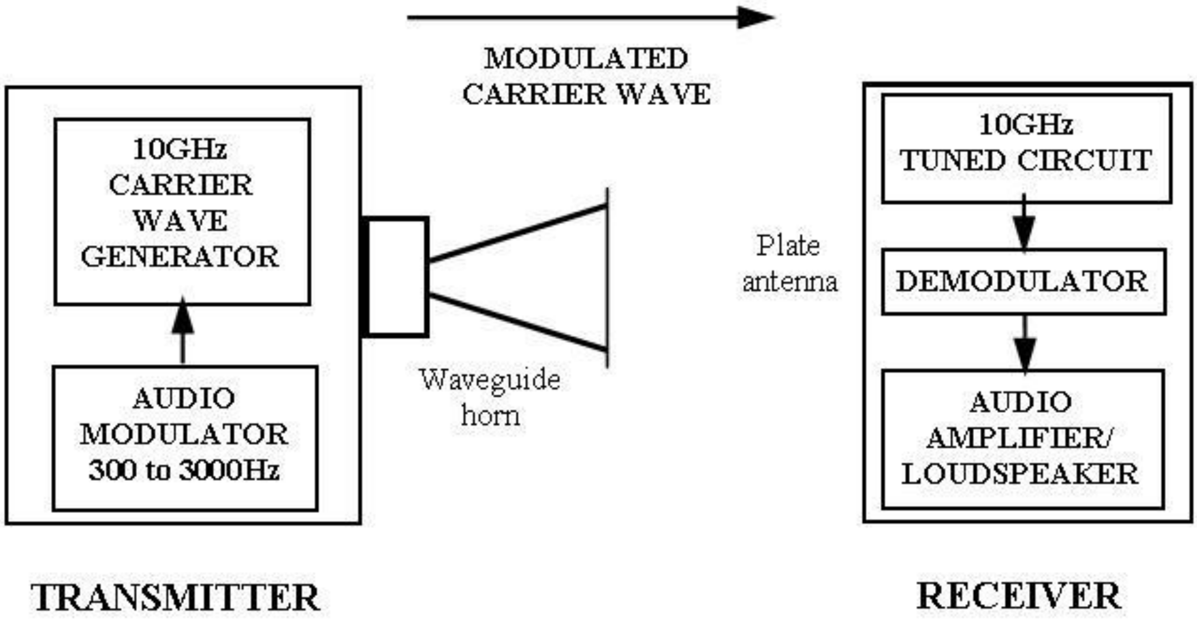
INSTRUCTIONS FOR USE

MICROWAVE TRANSMITTER / RECEIVER LA50-420/ LA50-430

INTRODUCTION

Electromagnetic waves cover the spectrum from "Long" radio waves, through Short waves and Microwaves to Infra-red, Visible and UV to X-rays and Gamma rays. This Microwave system provides a convenient apparatus for examining the properties of this special area of the E-M Spectrum.

SYSTEM OVERVIEW



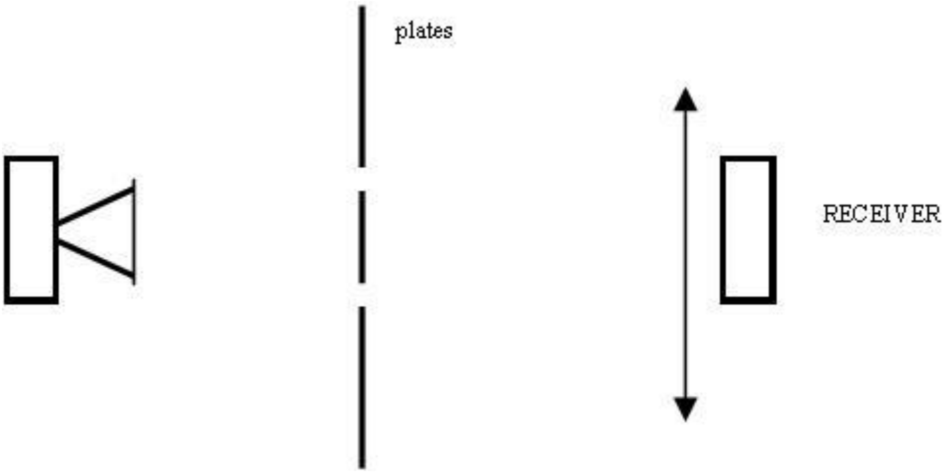
The system uses integrated Schottky diode modules tuned to the 10.587 GHz band which is a licence-free frequency commonly used for short range motion detection applications such as speed cameras etc. Amplitude Modulation (AM) is applied by a simple audio oscillator under the control of the user.

The receiver is a multi-element plate antenna which covers most of the target area on the front panel of the receiver unit. The output amplitude is adjustable to cope with varying sensitivities required.

INTERFERENCE

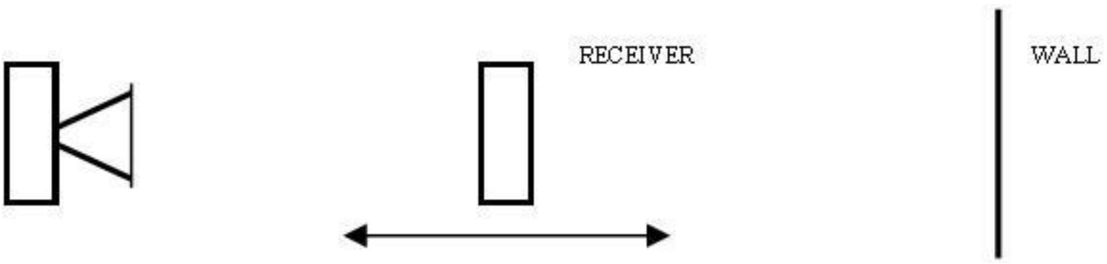
When two coherent wave sources meet the wave disturbances can either add together to give constructive interference or cancel each other to give destructive interference. If a detector is moved along a line perpendicular to the direction of wave propogation a series of high and low amplitude regions should be experienced.

With microwaves the two coherent sources can be derived from the single transmitter by using three metal plates. Two A4 size plates with a narrow one between can give two apertures, about 1.5cm wide and 5cm apart. Arrange the plates between the transmitter and receiver with the units about 70cm apart.

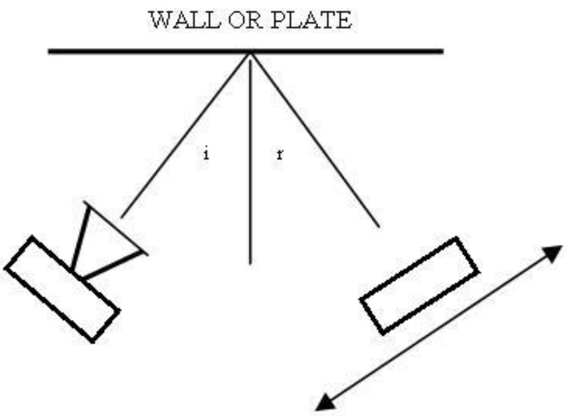


STANDING WAVES

Place the receiver between the transmitter and a suitable reflector such as a metal plate or the wall. If the distance between transmitter and wall is adjusted over a distance of about 2cm standing waves can be set up and as the receiver is moved along the direction of wave propogation a series of high and low amplitude positions will be found corresponding to nodes and antinodes in the wave. Two regions of low amplitude are separated by one halfwavelength of the microwaves and this should correspond to about 1.5cm



REFLECTION PROPERTIES

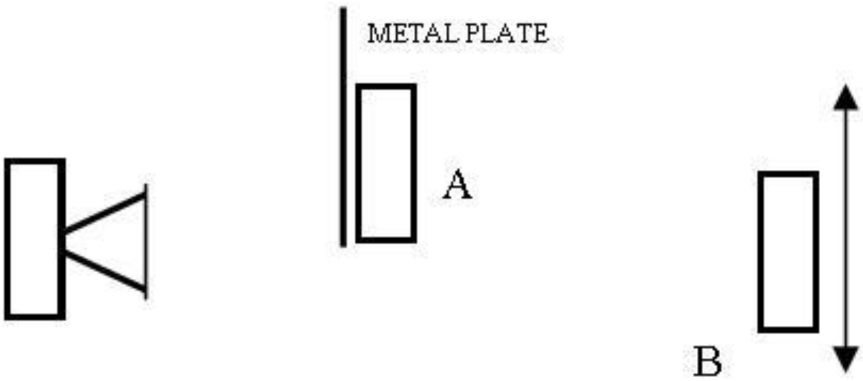


Arrange the system as in the diagram with the units about 70cm from a surface which may be either the wall or a solid material plate such as were used in the absorption experiments.

Monitor the output signal strength as the receiver is moved. Measure angles i and r for optimum signal. Try small and large angles for i and different reflecting materials.

DIFFRACTION PROPERTIES

Having established that the beam does not pass through metal plates, a plate can be used as a barrier around which diffraction can take place.



With the receiver in position A, few waves reach the antenna showing that waves do not pass through the barrier. If the receiver is moved out of the shadow of the barrier the amplitude increases dramatically. Move back to position A and then move the receiver further from the barrier closer to the line of position B. The signal strength will increase showing that the waves bend round into the shadow area. This effect is diffraction which can be demonstrated by water waves in ripple tanks and with light using lasers.

RADIO SPECTRUM

	Frequency	Wavelength
Long Waves	**30 kHz to 300 kHz**	**10,000 to 1,000m**
Long distance radio communication		
Medium Waves	**300 kHz to 3MHz**	**1,000 to 100m**
Local radio communication		
Short Waves	**3MHz to 30MHz**	**100 to 10m**
Amateur and CB radio communication		
VHF	**30MHz to 300MHz**	**10m to 1m**
FM radio, Police, "Walkie Talkies"		
UHF	**300MHz to 3GHz**	**1m to 10cm**
TV and Aircraft Communications		
Microwaves	**3GHz to 300GHz**	**10cm to 1mm**
Radar, Satellite, telephone and TV links		

Each frequency band has its own characteristics and by using this microwave system alongside other devices some of these characteristics can be explored. The most basic comparison, requiring the least equipment is between microwaves and light. By using an IR Link (or TV remote controller) and a radio system more detailed comparisons can be made.

PROPOGATION OF EM WAVES

There are various routes whereby EM waves can pass from a transmitter to a receiver over long distances for the purposes of communication.

1. Surface waves along the surface of the Earth. Low frequency Long Waves travel mainly by this method and have a range of thousands of kilometres.
2. Sky waves bouncing off the atmospheric layer called the Ionosphere. This works for Medium and Short radio Waves.
3. Space waves using Communications Satellites or "Line of Sight" for > 30MHz.

Over short distances we generally have line of sight but there could be absorbing barriers between the transmitter and receiver. It is useful to compare the absorption properties of each waveband as well as the reflection effects.

INVESTIGATIONS

GENERAL NOTES

10 GHz is well into the microwave band giving a wavelength of just over 3cm. The horn transmitter gives a directional beam and the signal strength is very low presenting no radiation hazard to the users.

The wave properties in this region of the waveband approximate to those of visible light and reflection, diffraction, refraction and interference can all be demonstrated. An accessory kit is available to facilitate the demonstration of wave phenomena but normal laboratory apparatus can be easily put to good use in a similar way. A probe receiver is also available which facilitates quantitative measurements.

Note that when used in a laboratory environment there will always be reflections from the surrounding walls, people and from the bench surface which will confuse the results, particularly when low amplitude signals are being investigated. Take sensible precautions to avoid such reflections. For example always arrange the transmitter to be aimed at the open room with people behind the horn. Bench reflections can be avoided by using two benches with a gap between, the transmitter being on one bench and the receiver on the other.

DIRECT TRANSMISSION AND ABSORPTION

Place the transmitter on the bench with the receiver about 70cm away and with the target surface facing the horn. Reduce the sensitivity on the receiver to a low setting and switch on the supplies at the mains.

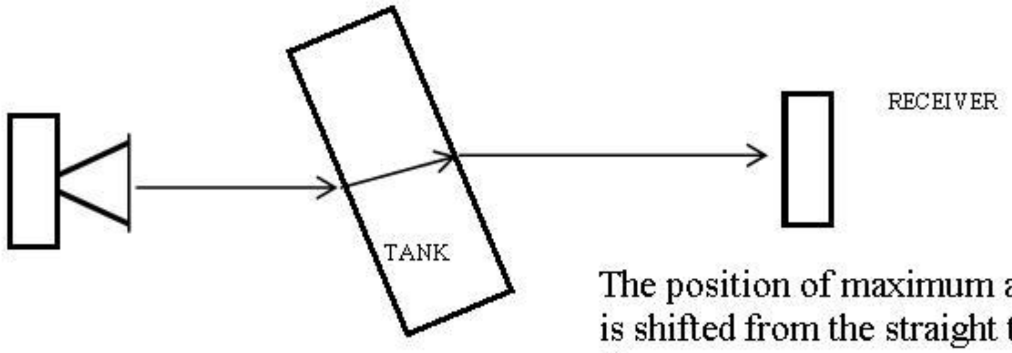
Increase the sensitivity setting to get a reasonable signal amplitude. The frequency of the modulation can be varied at the transmitter to show that the signal is coming from the transmitter and is being picked up by the receiver. Rotate either the transmitter or the receiver to show the directional properties of the beam.

Place various materials in the form of sheets about A4 size between transmitter and receiver. Materials to try are paper, card, thin wood such as hardboard, aluminium and steel plates. Vary the distance of the absorber from the horn noting any differences as the plate gets nearer or further from the horn.

REFRACTION PROPERTIES

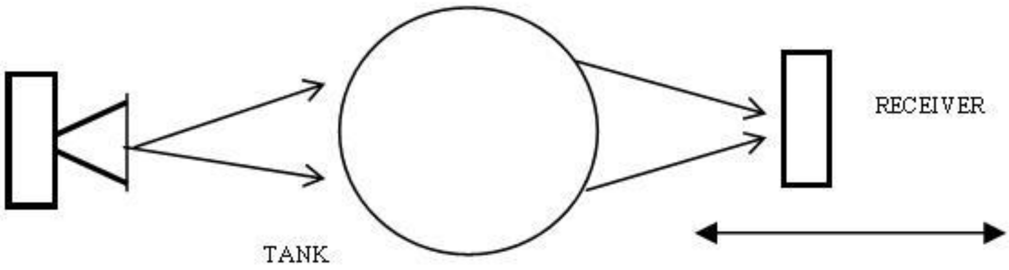
Microwaves can be refracted when they pass through a region which is denser than air but still transparent enough not to cause excessive absorption. The refraction rules pertaining to light waves apply i.e. if the waves approach the denser medium at an angle then they will bend towards the normal as they pass into the denser region.

For microwaves this is best demonstrated using a tank of water or tank of liquid paraffin, the latter giving slightly better results due to its greater density. The effects are not pronounced but serve as a useful introduction to the ideas that microwaves can be reflected from layers of dense air in the atmosphere due to Total Internal Reflection which is a refraction effect at very large angles of incidence.



The position of maximum amplitude is shifted from the straight through line

A circular trough can produce a “spherical lens” and produce a focussing effect for the waves.



Greatest amplitude at the focus.

NOTES

Other apparatus from Lascells Ltd. or major distributors.

MODULO 1	For showing AM FM modulation of a Carrier Wave.
ADC and DAC	For howing analogue and Digital conversion in Communications systems.
INFRA-RED LINK	For exploring the properties of Infra-red radiation as in communications.
RF Telemetry SYSTEM	For exploring the properties of 433 MHz radio waves.
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