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Institute of Electronics
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Radio Frequency Circuits Laboratory

Excercise 9
Experiments with a RF Sensor (Barrier)

Introduction

Microwave barriers, examined in his laboratory exercise, are used for protection of the restricted areas, such as warehouses, industrial areas, airports or military areas. The microwave barrier comprises a transmitter and a receiver which, when mounted facing each other, create a perimeter protection. The electromagnetic wave is send from the transmitter to the receiver. The disruption of the beam turns on the alarm.

The goal of this exercise is to turn on and test the microwave barrier using wavelength equal to several centimeters. You have to position the transmitter and the receiver, connect them and adjust them. You can observe the radiation and propagation of the waves during the start up procedure, and become acquainted with the structure of the microstrip directional antennas and simple control units.

Microwave barrier data sheet

The microwave barrier includes: microwave transmitter, microwave receiver, control unit and supply unit. The housings of the transmitter and receiver look the same. They are mounted on the steel posts of the perimeter equal to 76mm (fig.1)

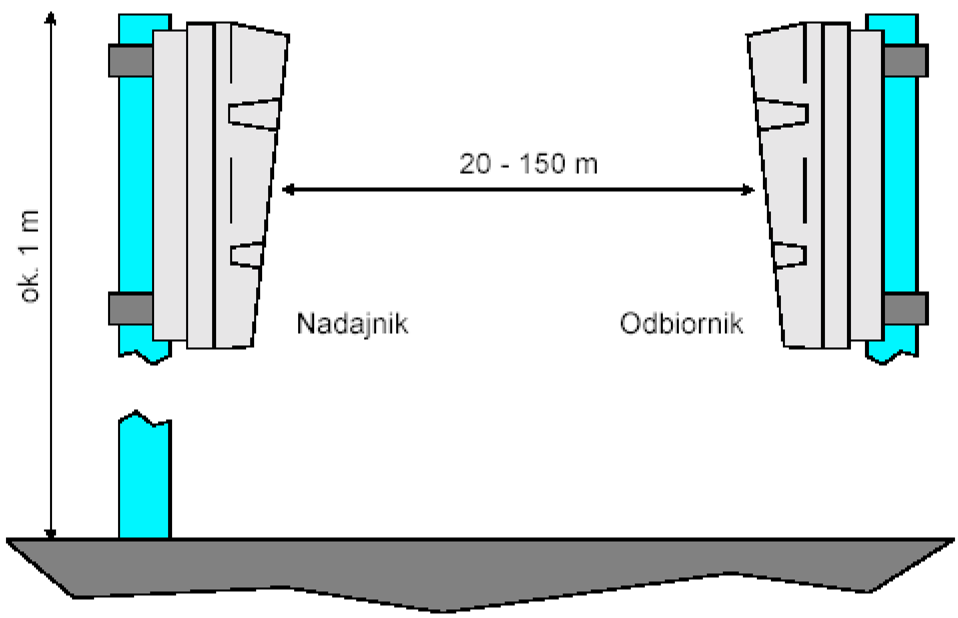


Figure 1. Arrangement and assembly of the posts of the microwave barrier.

Features:

Power input	10.5÷28V (dc)
Transmitter input power	~10mA
Receiver input power	~40mA
Transmitter power (EIRP)	400mW
Wave frequency	9.470GHz (pulse)
Number of channels (multiplex)	16
Transmitter – receiver distance	20÷150m
Operating temperature	(-35)÷(+60)ºC
Alarm signal output	relay contact (max. 200mA)

Sabotage supervision	switch contact (max. 200mA)
Remote testing	input current 2mA
Sensitivity regulation	16 degrees (very low ÷ very high)
Dimensions of the post for mounting the antenna	steel pipe Ø76mm thickness of the wall 5mm
Dimensions	height 510mm width 420mm depth 260mm
Unit weight	~15kg

Working principles of the microwave barrier

The control unit installed in the receiver generates the triggering impulses and sends them to the transmitter. When the pulse is generated, the electromagnetic beam of frequency 9.470GHz is emitted towards the receiver's antenna. In the normal operation mode the average power level of the emitted beam is set, which can reach the receiver. The disturbance of the beam causes the change of power. This change is detected by the receiver, the joints 9 and 10 of the transmitter are short circuited and the alarm signal is activated.

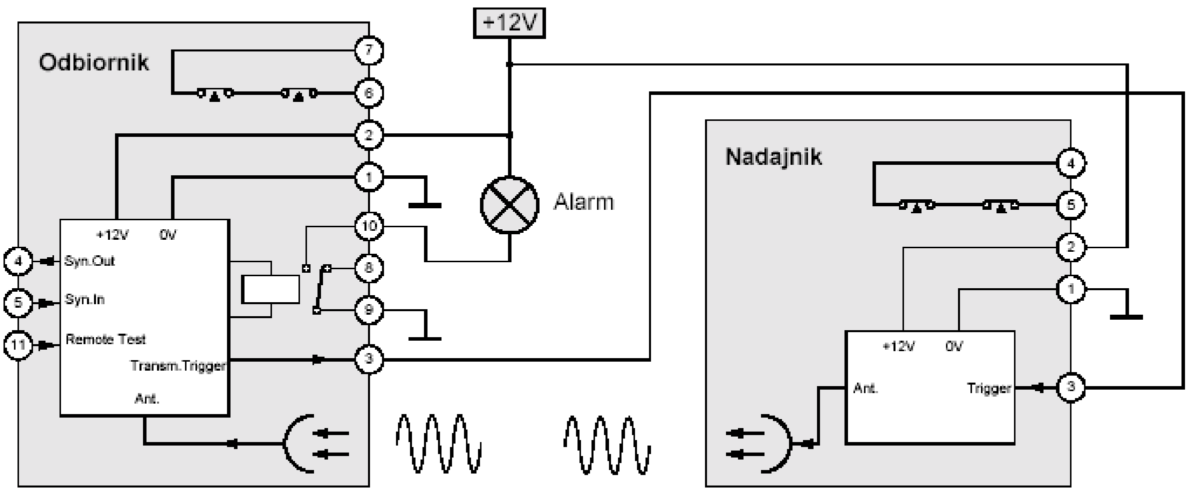


Figure 2. Schematic of the connection of the single microwave barrier.

In case of the complex systems composed of large number of the transmitter-receiver pair, the synchronization of triggering impulses is necessary, so that two different transmitters cannot be activated at the same moment. To achieve the synchronization, one of the receivers is chosen to be the superior one. It is connected to all the remaining receivers in such a way, that its output signal *Sync.Out* controls the input synchronization signals *Sync.In* of all the other receivers. To each transmitter-receiver pair the unique channel is assigned using *channel* switch inside the housing of each transmitter.

Positioning and connection

Transmitter and receiver of the microwave barrier are mounted on the steel posts concreted in the ground. Approximately 1m of the post must be above the ground surface. The distance between the transmitter and the receiver must be between 20 and 150 meters.

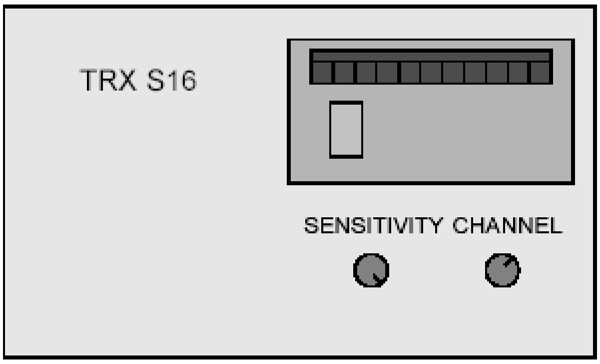


Figure 3. Adjustment panel of the receiver.

The input voltage (10.5 ÷ 28V dc) must be connected to the contacts 1 and 2 of the transmitter and the receiver. The trigger output of the receiver must be connected to the appropriate input of the transmitter. Contacts 8, 9 and 10 of the transmitter have to be connected to the signaling unit. After connecting the cables, it is necessary to adjust the position of the antennas and the sensitivity level, and select the channel (fig.3). The *channel* and *sensitivity* switches are place inside the housing of the antenna and are accessible after opening the panel.

The transmitter and the receiver must face each other in such a way, that the power of the received electromagnetic beam is possibly the highest. This value can be determined by measuring the voltage in *test point A* accessible after opening the cover of the receiver (fig.4). Proper horizontal positioning of the antennas can be achieved by rotating the transmitter or receiver on the post. Vertical position is regulated by plastic nuts placed inside the housing. For properly placed antennas, the voltage at the test point A should be in the range 20 ÷ 500mV (preferably ~100mV). The *Low Signal* and *Alarm* diodes (fig.4) should be off after the stabilization of the microwave barrier (1 minute after turning on the power supply).

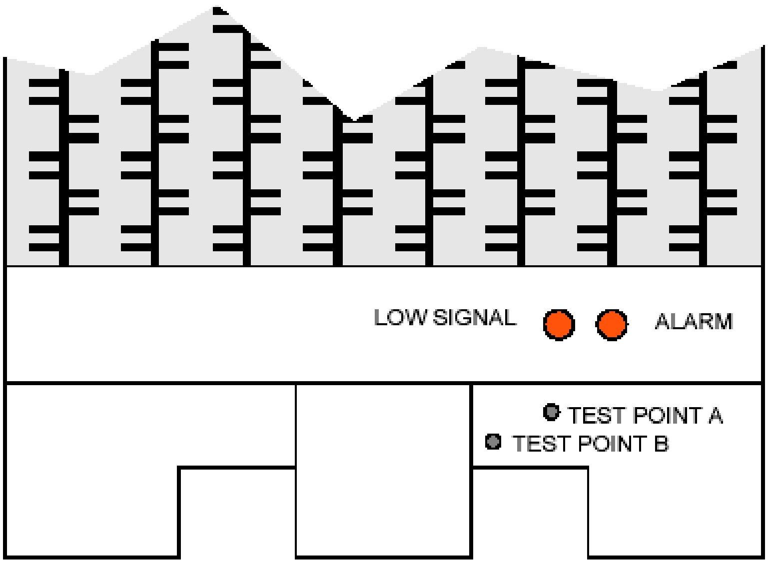
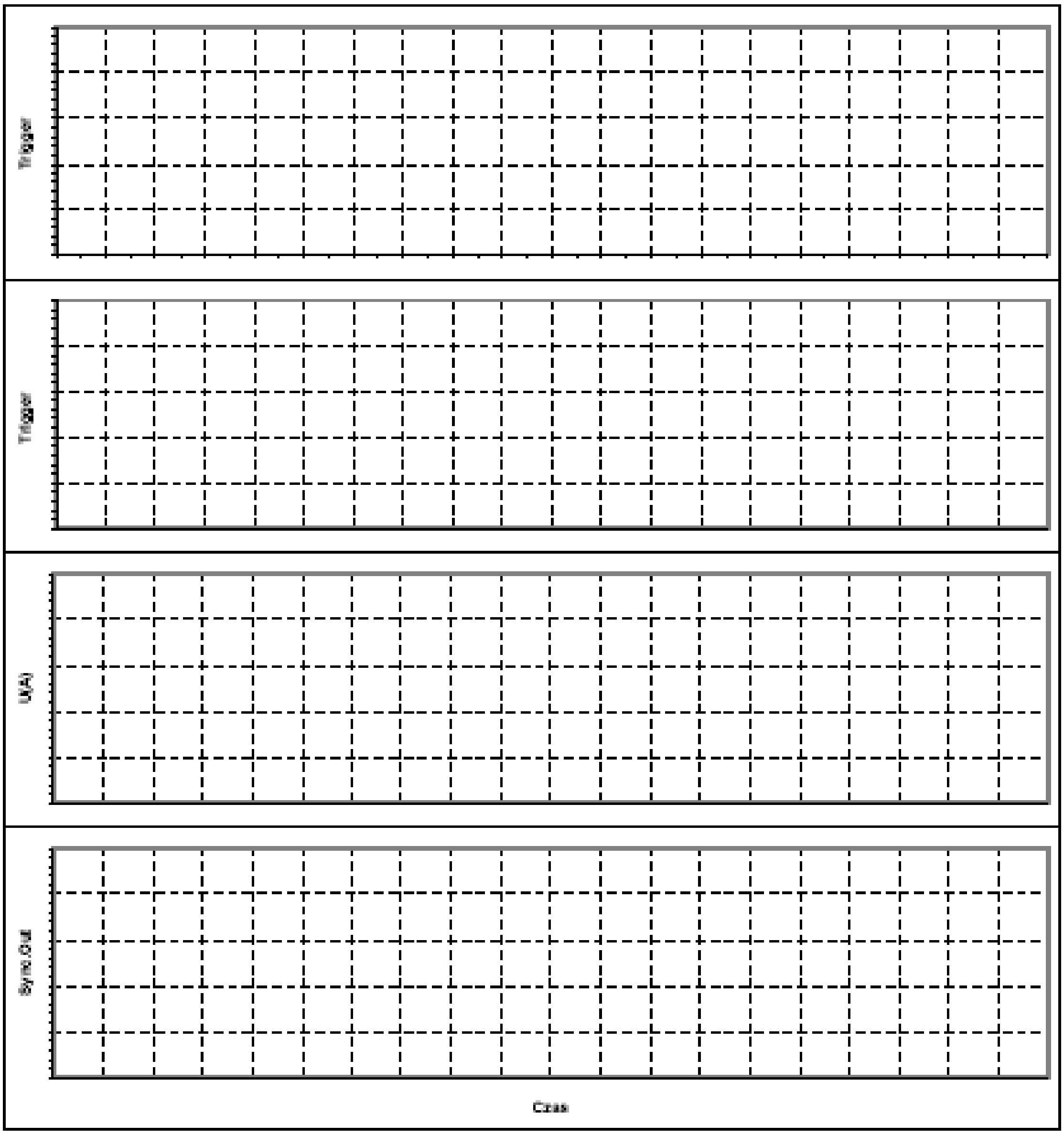


Figure 4. Control panel of the receiver.

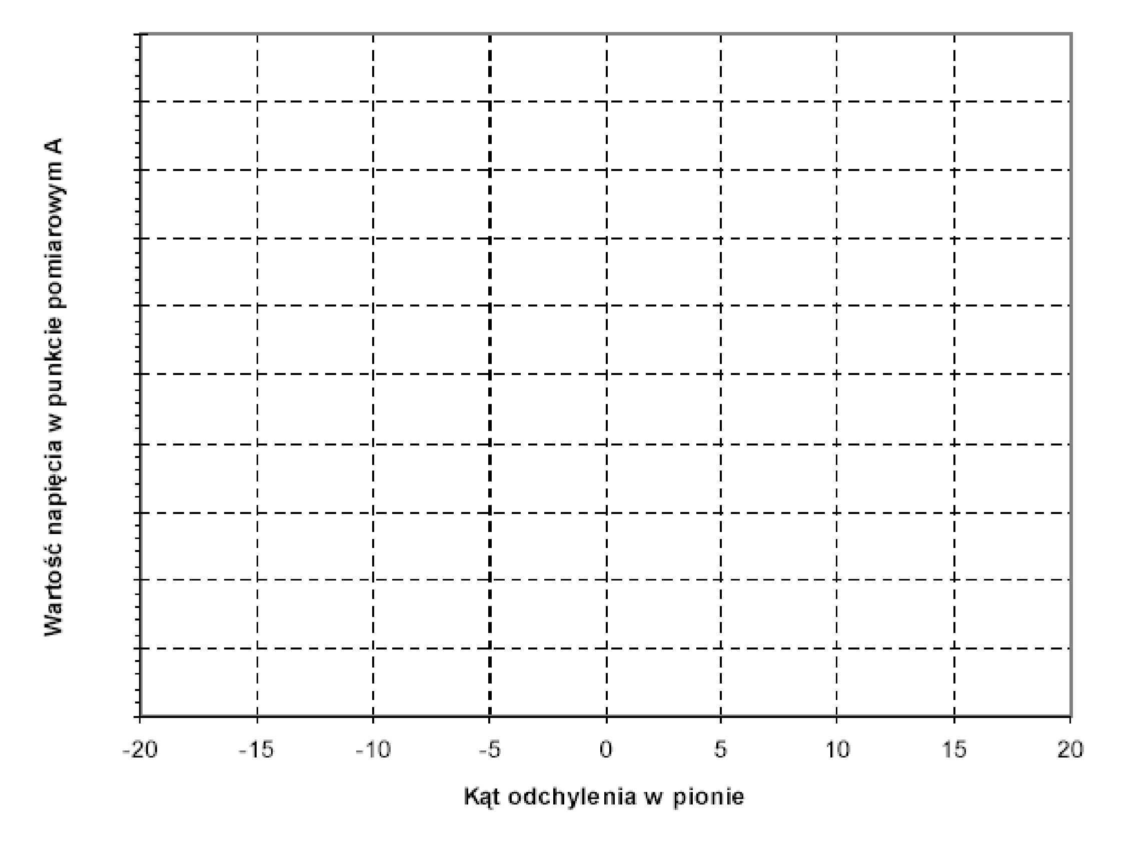
The sensitivity of the microwave barrier (*sensitivity* switch) should be set according to the needs of the operator and the terrain conditions. It requires performing several experiments. Notice that in case of setting too high level of sensitivity (10 to 16) the alarm signal can be turned on by wind or rain. In case of too low level of sensitivity, the barrier may not detect the intruder.

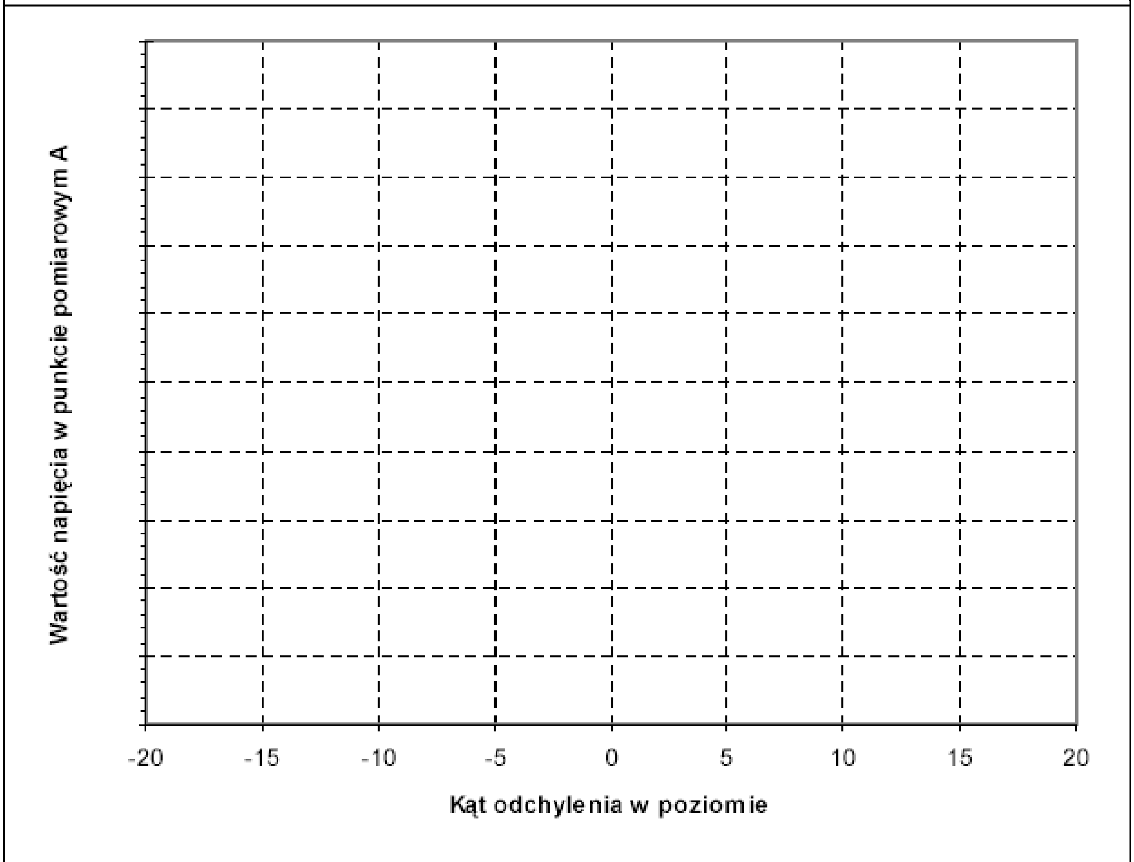
Experimental procedure

1. Position the transmitter and the receiver at the distance of 30 ÷ 40m from each other.
2. Connect the receiver trigger output with the transmitter trigger input.
3. Connect the alarm indicator to the relay contacts in the receiver.
4. Connect the power supply to both elements of the microwave barrier.
5. Connect the oscilloscope to the test point A and adjust the direction of the antennas of the transmitter and receiver so that the voltage has the maximum value.
6. Connect the dual channel oscilloscope to the *Sync.Out* and *trigger* outputs of the receiver. Sketch the voltage waveform for two different positions of the *channel* switch.



7. Connect the dual channel oscilloscope to the *Sync.Out* output and the test point A of the receiver. Sketch the voltage waveform at the test point A for one of the channels chosen in point 6.
8. Changing the angle of the transmitter antenna, sketch the dependence between the maximum voltage at the test point A and the angle of the antenna.





9. Position the antenna like in point 5. Select the optimum sensitivity level by crossing the barrier several times. Justify your choice.