ARGOS

MEMORANDUM

Subject:	Recommendations for using the RXG134 goniometer	
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1. Introduction

This document provides a list of all the advice and tips to help operators use goniometer efficiently, but it should be noted that different situations may require different procedures to achieve high-quality goniometric readings.

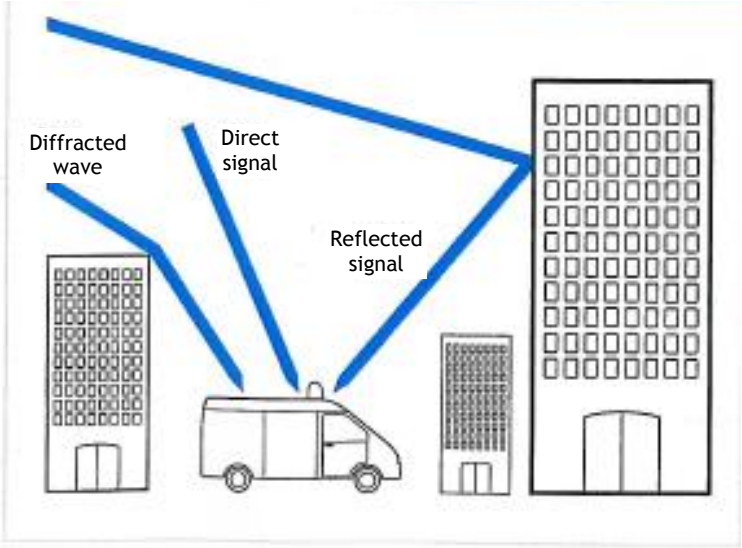
We shall consider two situations:

- In the open: at sea, on plains, savannas, etc. Flat terrain and/or with excellent line of sight.
- Restricted areas: canyons, valleys, town centers, etc. Irregular terrain and/or with poor optical visibility.

2. Notion of optical visibility/Wave path

Signals (radio broadcast, messages from a transmitter, etc.) are transmitted in the form of an electromagnetic wave, propagated through the air in straight lines. When such waves encounter obstacles on their path, they may be diffracted (i.e. only part of the initial signal is received) or reflected (only part of the signal is received, and with a slight time lag).

Propagation by multiple paths



On reception (by our GONIO, for example), all these signals become combined as a set of multi-path components: the signal received is the sum of the principal signal and of all the reflected signals (from the ground, vegetation, water surfaces, buildings or other structures, etc.).

Can this be avoided? No, unfortunately this is an inevitable physical phenomenon.

It is important to fully understand this phenomenon as it is the main cause of errors in goniometer readings. However efficient the instrument, its directional readings are bound to include errors.

Optical visibility depends on “line of sight”. Imagine that you are on a hill. The plain stretches out below you and you can perhaps see other hills several miles away with no obstacles between. If a transmitter is now placed on those distant hills and you use a goniometer right where you are, you will pick up the transmitter’s signals perfectly and your goniometer will give you the exact direction. In this case, you will have several miles of optical visibility.

Now add a large city between you and the transmitter; your signal will arrive attenuated and distorted by the multi-path phenomenon and your goniometer will not give such a precise reading. Your optical visibility will be the distance between you and the nearest significant obstacle.

Optical visibility increases with altitude: this is why a goniometer is capable of receiving signals sent from several thousand miles away if it is carried on an aircraft.

3. Recommendations for use in the open

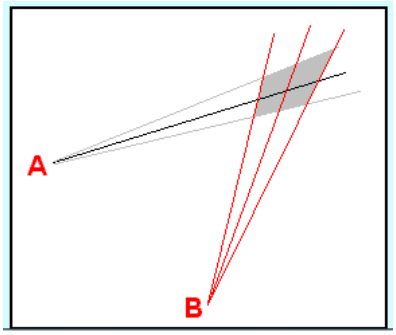
As we saw above, there is considerable optical visibility in an open area. This is the ideal situation. Signals are not, or only slightly, distorted. The goniometer can take very accurate readings.

For best performance, however, avoid:

- holding the antenna in your hand: use the mount provided,
- moving about too much: take several readings before deciding which direction to follow,
- taking a directional reading as an absolute measurement: it is only indicative.

As far as is possible, we recommend that you:

- move about according to the ham radio enthusiast's technique of "foxhunting": take several readings at different positions as shown below (the beacon is somewhere in the gray polygon):



- hold the antenna as high as possible: this will increase the goniometer's optical visibility,
- look for as open a position as possible;
- stay away from large metal objects (vehicles, hangars, constructions or slabs of reinforced concrete, etc.) that could affect the readings;
- keep away from buildings that might reflect electromagnetic waves, electrical or telephone wires, other antennas operating in the same waveband, and so on;
- check that the cable is correctly attached to the antenna and to the receiver;
- take three readings 30 to 50 meters apart and calculate the mean value of all three;
- read off the direction of the principal echo or what you consider to be the principal echo.

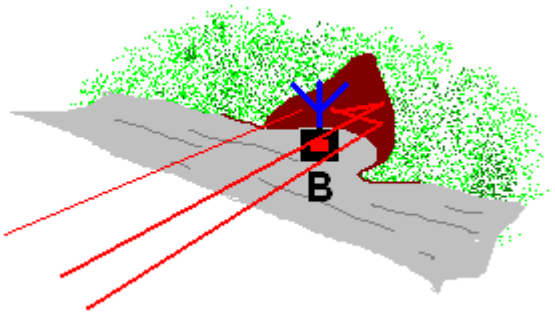
4. Recommendations for use in restricted areas

In this, the most complex, situation, the multi-path phenomenon predominates.

The effect is well-known to many users: in urban areas, even when using the most modern radiogoniometric devices, it is often impossible to use the readings and the display moves constantly around the points of the compass (Rohde & Schwarz, 2012).

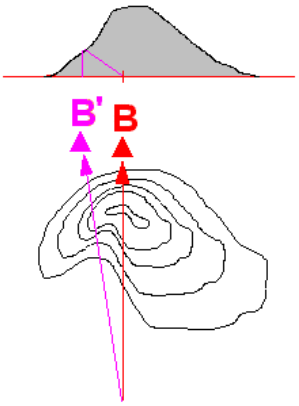
Depending on the situation, several phenomena can occur:

Signal reinforced by a natural reflector



The transmitter (B) is placed in front of a cliff-face, a tall building, a steep embankment or a quarry. The vertical surface reflects the waves emitted and the signal is reinforced, giving a distant operator the impression that the transmitter is much closer than it really is.
This troubling phenomenon can also occur when the receiver passes close to a wall or rock-face. The readings can be considerably stronger, as the reflected signal is added to the signal received directly by the antenna.

Influence of terrain on direction-finding

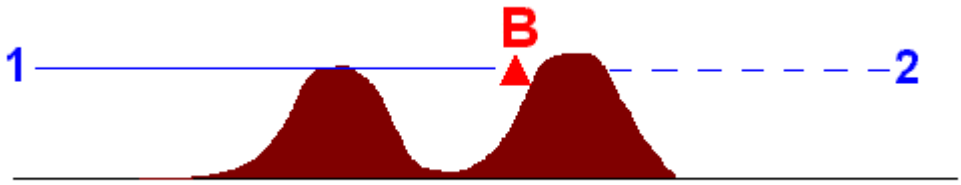


The figure opposite shows a transmitter B (in red) masked by a high hill. The signal from the transmitter is naturally considerably attenuated but remains audible, as the waves circumvent the obstacle. In this particular case, the shape of the obstacle and the position of the transmitter cause the signal to appear to come from the left (represented by B' in violet).
Equally, if a reading such as B' were to be plotted on the map as being to the right of the reading direction where there is relatively high terrain this could be interpreted to mean that the real position of the transmitter is further to the right. The more irregular the terrain, the greater the deviation.

Case of hunting for a transmitter in a mountain valley

In mountainous country it can be difficult to tell on which side of a valley a transmitter is stationed. If the elevation between the floor of the valley and the surrounding peaks is substantial, discovering the position of the transmitter is no easy task.

From a distance



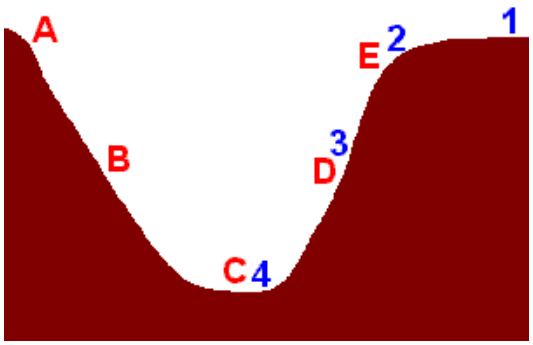
If the transmitter is close to a peak, the detection phase from a distance can provide useful clues.

Operator 1 has a direct line on the transmitter: the signal received will be clearer, stronger, and will be polarized vertically.
Operator 2 does not receive the signal directly: the signal will be blurred, considerably weaker, and will probably be polarized horizontally.

Approach

First you need to identify the valley. This is best done by visiting each valley to compare the strength of the signal.

Final phase



Depending on your position (numbers 1 to 4 in blue), you will pick up the transmitters (letters A to E in red) differently.
1 – Transmitter A loud and clear.
1 - Transmitters E and B less strongly but clear.
1 - Transmitters C and D weak and blurred (reflections off the left-hand slope).
2 - Transmitters A and B loud and clear.
2 - Transmitters C and D weakly, with multiple reflections off the opposite slope (on the left-hand side of the figure)
2 - Transmitter E very loud
3 - Transmitters A et B loud and clear
3 - Transmitters C and E weakly, with multiple reflections off the opposite slope (on the left-hand side of the figure).
3 - Transmitter D very loud
4 - Transmitters A, B, D and E seeming to come from everywhere at once, one moment from the left-hand slope, then from the right-hand slope.

Starting at the bottom is the worst way to look for a transmitter in a deep valley, for two reasons:
- going up is more difficult than coming down,
- the presence of multiple and varied reflections complicate the search considerably.

Whenever possible, start from the highest position, with one (or more) teams on each crest.
By following the crest you can constantly measure the direction of the strongest signal. If you have the impression that you have gone past the transmitter, retrace your steps until the transmitter seems to be on the opposite slope. You will then only have to go directly down towards the signal, doing your utmost to distinguish between the direct signal and any reflections. The strength of the signal will rise or fall depending on the position of the transmitter.
A – At Position 1, the signal is loud and clear. At Position 2, the “military crest” (position from which the floor of the valley is visible), the signal is no stronger but on the contrary tends to become weaker the further you descend.
B – At Position 1, the signal is fair but increases in strength and its direction becomes more precise as you approach Position 2. The signal remains constant as far as Position 3 and then gradually decreases.
C – At Position 1, the signal is very weak but strengthens as you descend.
D – At Position 1, the signal is weak, with many reflections off the opposite slope (with the direction varying constantly). At Position 2 the signal increases slightly and the direction becomes firmer. As you approach Position 3, the signal increases until it overrides the reflections.
E – The easiest case, with the signal fairly strong and strengthening very rapidly.